i-WIN INSTITUTE

CLASS 11
BOTANY MODULE - 1

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01 Living World, Monera, Fungi & Plant Kingdom

Binomial Nomenclature

- It is a system of providing distinct and proper scientific names to organisms, each consisting of two words, first generic and second specific.
- Binomial nomenclature for scientific naming of organisms was developed by Carolus Linnaeus in 1751 (*Philosophia Botanica*, 1751).
- All valid names for animals under binomial nomenclature are the ones given by Linnaeus in the tenth edition of his book *Systema Naturae* published in 1758.
- All valid names for plants are the ones given by Linnaeus in his book *Species Plantarum* published in 1753.
- The scientific or technical name of a species consists of two words in Latin, e.g.; *Mangifera indica* (Mango), *Homo sapiens* (Human), *Apis mellifera* (Honey Bee).
- The first word is the generic name or genus to which the species belongs. It is like a noun. It's first letter is always written in capital.
- The second word is the specific name which identifies the species itself. It's first letter is small except when it represents a very important or sacred place or/of personality, e.g; *Pinus Roxburghii* (instead of Pinus roxburghii).
- The name of the discoverer is appended at the end of two word name either in full or in abbreviation, e.g.; *Mangifera indica* Linn, *Homo sapiens L.* (Homo sapiens Linnaeus).

Codes of Biological nomenclature –

- **ICBN** (1961) – International code of botanical nomenclature.
- **ICZN** (1964) – International code of zoological nomenclature.
- **ICBacN** or **ICNB** International code of Bacteriological nomeclature.

➢ These are revised regularly by the International commissions of botanists, zoologists and bacteriologists.

➢ ICBN – Book of rules of nomenclature.

1. Collection of rules regarding scientific nomenclature of plants is known as ICBN.

2. ICBN was firstly proposed by : Sprague, Hitchcock, Green (1930).
3. ICBN was first accepted and published in 1961.
4. 12th international congress, Leningrade revised ICBN in 1975.
5. After revision ICBN was republished in 1978.

   So the ICBN was published twice first in 1961 and later on in 1978.

➢ The ICBN is divided into three parts : Principles, Rules and Recommendations.

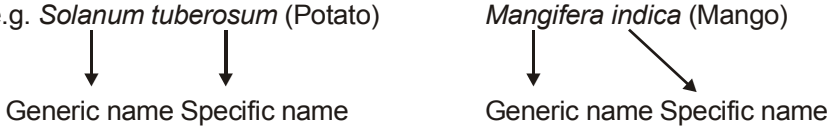
Main rules of ICBN

1. According to binomial system name of any species consists of two names :–

   (i) Generic name – Name of genus

   (ii) Specific name – Trival name/name of species

   e.g. *Solanum tuberosum* (Potato) *Mangifera indica* (Mango)

2. Generic names of different genus should not be same in any one kingdom.

   e.g. Potato can not be named as *Mangifera*.

   However they can be repeated in different kingdoms.

   e.g. *Bougainvillea* – It is name of a plant and an animal.

3. Specific name can be repeated in one kingdom.

   e.g. *Saraca indica, Mangifera indica*

4. In plant nomenclature (ICBN) tautonyms are not valid i.e. generic name and specific name should not be same in plants.

   e.g. *Mangifera mangifera*

   But tautonyms are valid in animal nomenclature (ICZN – International Code for Zoological Nomenclature)

   e.g. *Naja naja* (Indian cobra), *Rattus rattus* (Rat).

5. Length of generic name or specific name should not be less than 3 letters and not more than 12 letters.

   e.g. *Mangifera indica*

   Exception :– *Riccia pathankotensis* – More than 12 letters.

   According to ICBN this name is not valid but this name was proposed before 1961, so it is valid.

6. First letter of generic name should be in capital letter and first letter of specific name should be small letter.

   e.g. *Mangifera indica*

   but if specific name is based on the name of some person, its first letter will be in capital letter.

   e.g. *Chaetomium Subramaniella*

7. When written with free hand or typed (with type writer) then generic name and specific name should be separately underlined. But during printing name should be italized.

8. Name of scientist (who proposed nomenclature) should be written in short after the specific name.

   e.g. *Mangifera indica* Linn.

9. Name of scientist neither underlined nor written in italics, but written in roman letters (simple alphabets).

10. If any scientist proposed wrong name then his name should be written in bracket and the scientist who corrects the name will be written after the brackets.

    e.g. *Tsuga canadensis* (Lin.) Salisbury

    Note : Linnaeus named this plant as *Pinus canadensis*.

11. Scientific names should be derive from latin language because latin is dead language. It will not change in form or spelling with the passage of time.

Trinomial System

- Proposed by Huxley and Stricklandt.
- According to this system name of any plant or species is composed of three names :–

(i) Generic name

(ii) Specific name

(iii) Subspecific name (Name of variety)

- When members of any species have large variations than trinomial system is used. On the basis of dissimilarities this species is classified into sub species –

  e.g. *Brassica oleracea* var. *botrytis* (cauliflower)

  Brassica oleracea var. *capitata* (cabbage)

  Brassica oleracea var. *caulorapa* (knol–khol)

Advantages of Scientific names

- Every species has a single and specific name consisting of two (or rarely three) words.
- Every organism known to science has been provided with a scientific name irrespective of its importance.

- There is no possibility of any change in the spelling of a scientific name as the latter has been derived from dead Latin language.
- The names are of universal application for all the countries and the languages.
- The name indicate relationship of a species with others present in the same genus.
- A wrong name can easily be corrected.
- A newly discovered organism can be easily provided with a new scientific name.

CLASSIFICATION

Biological classification

- It is the scientific arrangement of organisms in a hierarchial series of groups and subgroups on the basis of similarities and differences in their traits so as to bring out their relationships. It is just like arranging books in a library subject–wise, title–wise and author–wise in a proper sequence.

Objectives of Classification

- To identify and describe all the possible types of species.
- To arrange the species in various categories on the basis of their similarities and dissimilarities.
- To evolve a truely natural or phylogenetic system which should indicate origin and evolution of the species.
- Helping in easy identification of species.

Systems of Classification

Both historical and modern systems of classification can be divided into three types of systems :–

1. Artificial system 2. Natural system 3. Phylogenetic system

1. Artificial system

- Artificial system is a system of classification which is based on comparison of one or a few characters. The chosen characters may be those of habitat, habit and morphology.
- Theophrastus (370–284 B.C.) distinguished plants into herbs, shrubs, undershrubs and trees.
- Plant classification put forward by Linnaeus (1735–37) is also artificial though he took highly conserved trait of sex organs as the basis of his classification–nonandria, monandria, diandria, polyandria, etc.
- Out of several artificial systems, the best is of Linnaeus.

2. Natural System of Classification

- A system of classification based on the comparison of a large number of near permanent characteristics that bring out natural affinities of organisms is called natural system of classification.

- The first natural system of classification for animals was proposed by Linnaeus.
- The first natural system of classification for plants was proposed by Schimper (1879) and de Jussieu and elaborate by Eichler (1883).
- A natural system of classification for higher plants was worked out by Bentham and Hooker in their *Genera Plantarum* (1862–1883) (3 vol.).
- The characters employed in natural system of classification include those of study of form (morphology), internal structure (anatomy) development (embryology or ontogeny) reproduction, cell structure (cytology), life processes (physiology), behaviour and biochemistry.
- The characteristics are helpful in bringing out maximum number of similarities in a group and comparable differences with other group of organisms.

Differences between Natural and Artificial System of Classificati

Sr. No.	Natural System	Artificial System
1	It employs a large number of characters.	An artificial system uses only one or a few characters.
2	The characters are not related to habit and habitat.	It often employs habit and habitat as criteria.
3	The characters are stable.	The characters are liable to change with change in environment.
4	The system uses characters from morphology, anatomy, cytology, ontogeny, molecular biology and genetics.	It is based on morphological or reproductive traits. Others are not used.
5	Related organisms occur in the same group.	Related organisms are often placed in different groups.
6	Unrelated organisms do not occur in the same group.	Unrelated organisms are often placed in the same group.
7	It brings out natural relationships.	It does not give any idea about natural and phylogenetic relateionships.

3. Phylogenetic System of Classification

- It is a system of classification that indicates the evolutionary or phylogenetic relationships of organisms.
- Phylogenetic system of classification is based on fossil record, biochemical, anatomical, karyotype and other studies.
- It tries to bring out historical order in which the various taxa evolved as a likeage or branch of the past organisms. Therefore, it is also called Cladistics.
- Phylogenetic system of plant classification was first initiated by Engler and Prantl (1887–1899) in *Die Naturalichen Pflanzen Familien*.
- Modern attempts at developing a phylogenetic classification of flowering plants are those of Cronquits, Hutchinson (1926, 1973), Takhtajan (1967).

- Takhtajan has likened classification without phylogeny as bones without flesh (A system of phylogeny of flowering plants, 1967).

KINGDOMS OF LIFE

TWO KINGDOM CLASSIFICATION

It is a system of classification in which all the organisms of the world have been divided into two kingdoms of animalia and plantae. The system was formalised by Linnaeus in 1758.

Kingdom Plantae

It includes all plants. They have a spread out appearance with commonly green parts. Plantae contains flowering plants, gymnosperms, ferns, bryophytes, algae, fungi, lichens and bacteria.

Kingdom Animalia

The kingdom contains all the animals. Animals are generally charcterised by ingestive type of nutrition and locomotion. Members of the kingdom animalia are protozoans, sponges, jelly fishes, worms, insects and other arthropods, molluscs, star fishes, frogs, reptiles, birds and mammals.

Objections

Two–kingdom classification was proposed in the period when details of cell structure were unknown. Therefore, a number of shortcomings occur in the system.

1. **Viruses –** They have been placed in kingdom plantae of two–kingdom classification. However, viruses are neither plants nor animals. They do not have a cellular structure or a metabolic machinery of their own. Viruses lie on the border–line between living and the nonliving.
2. **Prokaryotes –** They do not have sap vacuoles, membrane bound organelles, true nucleus, spindle apparatus and sexual reproduction. Prokaryotes cannot be related to plants which are eukaryotic.
3. **Motile Algae –** *Chlamydomonas* and a number of other unicellular algae possess cilia or flagella for locomotion in the aquatic habitat.
4. **Dual Organisms –** Organisms like *Euglena* have features of both plants and animals. They are unicellular, motile flagellate organisms with chloroplasts. They perform photosynthesis in the presence of light. In dark, they lose chloroplasts and become saprotrophic or holozoic. Organisms like *Euglena* are studied by both botanists and zoologists.
5. **Slime Moulds –** They have no cell wall in the vegetative phase. Nutrition is holozoic like animals. Cell walls develop in the reproductive stage.
6. **Fungi –** They are included amongst plants though they are quite different in structure, physiology, reproduction, food reserve and absence of chlorophyll.
7. **Unicellular Organisms –** Protozoans have little resemblance to animals. Many of them have green, brown or red colouration.

Five Kingdom Classification

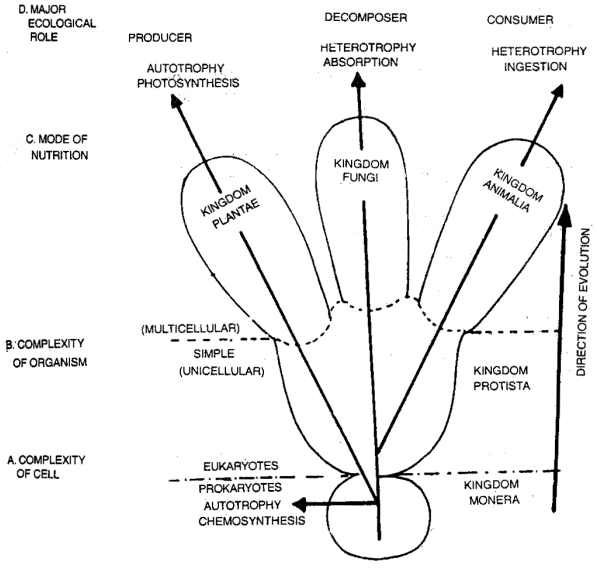
- It is a mode of classification in which living beings have been distributed into five kingdoms.
- The classification was proposed by american taxonomist R.H. Whittaker in 1969.
- It excludes viruses from living beings.
- The five–kingdoms are monera, protista, fungi, plantae and animalia. Whittker (1969) used three criteria for delimiting the five kindoms–complexity of cell structure, complexity of body structure and mode of nutrition.
- He also laid stress on bringing out their ecological life styles and phylogenetic relationships.

1. Complexity of Cell Structure

- Structurally cells are of two types, prokaryotic and eucaryotic.
- Prokaryotic cells do not have a true nucleus, membrane bound cell organelles (mitochondria, plastids, lysosomes, Golgi bodies, etc.) and spindle apparatus. Ribosomes are present but are smaller, 70 S in nature.
- Eukaryotic cells possess true well organised nucleus, membrane bound cell organelles and spindle apparatus for division. Ribosomes are 80 S in cytoplasm and 70 S in two of the cell organelles (mitochondria and plastids).

2. Complexity of Body Structure

- Organisms have two types of body structure, unicellular (acellular) and multicellular.
- Colonial organisation in considered to be altered expression of unicellular structure.
- Multicellular organisation has various types of complexity–cellular level, tissue level, organ level, and organ–system level.



The Five Kingdoms of Life

3. Modes of Nutrition

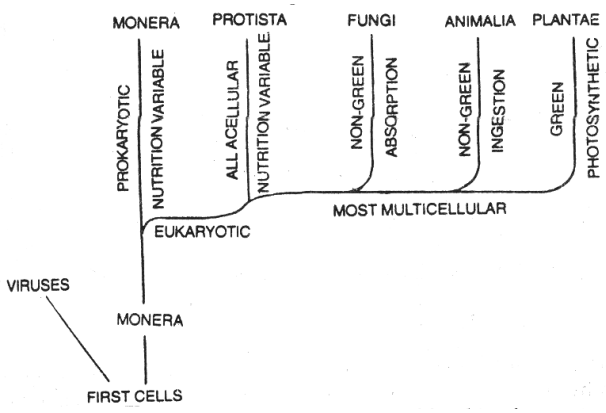
- It is of two main types, autotrophy and heterotrophy.
- Autotrophy is manufacture of organic food from inorganic raw materials. Solar energy is required for this.
- In photosynthesis, light energy is used for manufacture of food.
- Photosynthesis performed by photoautotrophic bacteria is anoxygenic (without liberation of oxygen).
- Blue–green algae and eucaryotic photoautotrophs perform oxygenic photosynthesis which liberates oxygen. It is also called holophytic nutrition.
- Heterotrophy is mode of nutrition in which ready–made organic food is obtained from outside.
- In ingestive heterotrophy solid or particulate food is taken in. It is also called phagotrophy or holozoic nutrition.
- In absortive heterotrophy, soluble food is taken from outside. It is of two types, saprobic and parasitic.
- In parasitic nutrition, the food is absorbed directly from another living organism or host. In saprobic or saprotrophic nutrition, food is obtained from organic remains.

4. Ecological Life Styles

- There are three ecological life styles–producers, consumers and decomposers.

5. Phylogenetic Relationships

- The earliest living froms produced prokaryotic organisms or monerans.



Phylogenetic relationship of five kingdoms

- Monera gave rise to protista, most probably through association of several types of primitive and advanced monerans.

- There are several types of protista. Fungi, plants and animals have developed from different types of early protistans.

KINGDOM MONERA (The kingdom of Prokaryotes)

- Monera is the kingdom of all prokaryotes. It is, therefore, also called prokaryota. The important monerans are bacteria, mycoplasma, actinomycetes and cyanobacteria (or blue–green algae).
- The organisms are unicellular, colonial, mycelial (e.g., actinomycetes) and filamentous (e.g., many cyanobacteria like *Anabaena*).
- Genetic material is not organised into true nucleus. Instead, naked DNA (without hisone association) lies coiled directly inside the cytoplasm. It is called nucleoid. The same is also called prochromosome because it is equivalent to a single chromosome but without the organisation of the latter.
- Nutrition is varied. Both autotrophy and heterotropy are present. Chemoautotrophs use chemical energy for synthesis of food. The process is called chemosynthesis. Photoautotrophs employ solar radiations for food synthesis. The process is called photosynthesis. It is anoxygenic (without liberation of oxygen) in photoautotrophic bacteria and oxygenic (with liberation of oxygen) in cyanobacteria (blue-green bacteria or algae). Heterotrophy is obtaining organic food from outside. In monera, heterotrophy is of absorptive type. It is saprotrophic and parasitic. Saprotrophic monera are important decomposers and mineralisers of biosphere alongwith the fungi.

KINGDOM PROTISTA – The kingdom of Unicellular Eukaryotes

- It is the kingdom of all unicellular and colonial eukaryotes. The important members are diatoms, dinoflagellates, euglenoids (= flagellates), slime moulds and protozoans (sarcodines, ciliates and sporozoans).
- Nutrition is diverse-photosynthetic, ingestive (phagotrophic or holozoic) and absorptive (both , saprotrophic and parasitic). Ingestive or holozoic type of nutrition occurs in only wall-less protistans.
- Phytoplankton or photosynthetic plankton mostly belong to protista. They are the major producers of aquatic system. Rather 80% of the total photosynthesis in the biosphere is carried out by them.
- A few protists have two or more types of nutrition. *Euglena* and its relatives perform photosynthesis in the presence of light (holophytic nutrition). In dark and in the presence of organic matter, the protists become saprotrophic and holozoic. They thus possess mixotrophic nutrition.
- Slime Moulds have a flexible life cycle. They are intermediate between wall–less and walled protistans. In the feeding state, the body is a wall-less amoeboid plasmodium. Nutrition is of ingestive or holozoic type. During reproductive state, Slime Moulds develop walls and become multicellular.

DRAWBACKS

- Dinoflagellates have a different type of nuclear matter which is devoid of histone. Here, a spindle apparatus is not formed during nuclear division.

- Slime Moulds do not fit in protista.
- It is very difficult to find differences between protistan algae and algae of kingdom plantae.

KINGDOM FUNGI – The Kingdom of Multicellular Decomposers

- It is the kingdom of multicellular or multinucleate achlorophyllous and spore–producing eukaryotic organisms like *Rhizopus,* mildews, rusts, mushrooms, bracket fungi, morels, etc.
- Nutrition is heterotrophic and absorptive. Fungi secrete digestive enzymes through their cell walls into the outside environment for converting the complex organic matter into simpler and soluble state. The same is absorbed. Fungi are saprobes if they obtain nourishment from decaying organic matter and parasites if they get the same from living organisms.
- Yeasts are exceptional in being unicellular. Howeyer, they do form pseudofilaments. Yeasts resemble multicellular fungi in their sexual reproduction.

  Kingdom fungi of Whittaker includes all fungi of two–kingdom classification except Slime Moulds.

KINGDOM PLANTAE – The Kingdom of Multicellular Producers

- Kingdom plantae or metaphyta includes all coloured multicellular photosynthetic organisms called plants. The important constituents are green algae, brown algae, red algae, bryophytes, pteridophytes, gymnosperms and angiosperms (flowering plants).
- Nutrition is autotrophic and photosynthetic. Plants trap solar energy with the help of green photosynthetic pigments or chlorophylls and carotenoids. They obtain water, carbon dioxide and essential inorganic elements from outside and synthesise organic food in the process of photosynthesis.

KINGDOM ANIMALIA – The kingdom of Multicellular Consumers

- Kingdom animalia or metazoa includes all animals of the two kingdom classification except protozoa. The main groups represented in the kingdom are sponges, coelenterates, worms, annelids, arthropods, molluscs, starfishes, fishes, amphibians, reptiles, birds and mammals.
- Organisms are multicellular, eukaryotic, without cell wall and photosynthetic pigments.
- Nutritionally animals are heterotrophic being holozoic or ingestive. Some are parasitic, living within tissues of plants and other animals. Symbiotic association is found between cellulose digesting protists and wood eating termites and cockroaches. Some green algae (*e.g., Chlorella*) forms association with *Hydra* (a coelenterate).

Disadvantages of Five Kingdom Classification

- It is very difficult to make distinction of unicellular and multicellular forms of algae. Placing algae in three kingdoms seems to be unrealistic.
- Slime Moulds do not fit into kingdom protista.

- Viruses do not find any place in this system of classification.
- Red and Brown algae are not related to other members of kingdom plantae.
- Unicellular, eukaryotic, green algae chlamydomonas is placed in Kingdom Plantae.

PLANT GROUPS

THALLOPHYTES

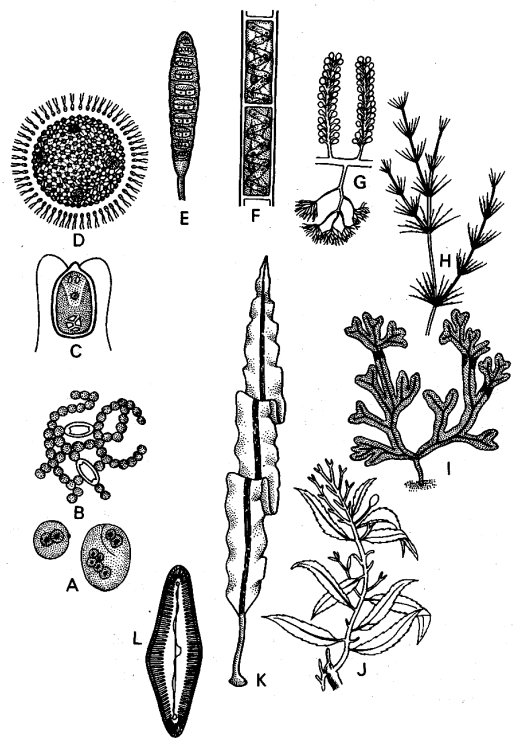
1. The term 'thallophyte' was used for the first time by Endlicher for the plant having a thallus–like body.
2. Plant body does not have root, stem and leaves.
3. Main plant is haploid and gametophyte.
4. Plant body is either unicellular or multicellular.
5. Plants are either autotrophic or heterotrophic.
6. Plants lack vascular tissues.
7. Reproductive organs are usually unicellular. When multicellular they are not surrounded by a jacket of sterile cells. All cells of a reproductive organ are fertile.
8. Embryo is not formed. The zygote after meiosis directly develops into a new plant.

(I) ALGAE

'Alga' is a latin term. The branch of botany dealing with the study of algae is called 'algology' or 'phycology'. The scientist who studies algae is called an algologist or phycologist.

Important characters of algae –

1. The algae contain chlorophylls and are autotrophic. Usually they grow in water.
2. Their plant body is thallus–like which is neither divided into root, stem and leaves nor into various tissue systems.
3. The reproductive organs are generally unicellular. When multicellular, they are not covered by a jacket of sterile cells.
4. The cell wall is made up of cellulose, protein or silica.
5. Embryo is not formed as a result of gametic union.
6. Some common examples are *Gleocapsa*, *Nostoc*, *Chlamydomonas*, *Volvox*, *Ulothrix*, *Spirogyra*, *Caulerpa*, *Chara*, *Fucus, Sargassum, Laminaria*, *Diatom*.



Different types of algae. A. *Gleocapsa*, B. *Nostoc*, C. *Chlamydomonas*, D. *Volvox*, E. *Ulothrix*, F. *Spirogyra*, G. *Caulerpa*, H, *Chara*, I. *Fucus,* J. *Sargassum,* K. *Laminaria*, L. *Diatom*.

(A) Reproduction

It is of three types – Vegetative, asexual and sexual.

(i) Vegetative reproduction

(a) Cell division or fission – A cell divides into two cells by mitotic division. The method is common in unicellular algae.

(b) Fragmentation – It is a common method in multicellular algae in which a thallus breaks up into small fragments. Each fragment then develop into a new individual. In blue–green algae, vegetative reproduction takes place with the formation of hormogonia.

(ii) Asexual reproduction

(a) Zoospores – These are naked, motile, flagellated cells, e.g. *Ulothrix, Ectocarpus*.

(b) Aplanospores – These are thin–walled, non–motile, non–flagellated cells, e.g. *Ulothrix*.

(c) Hypnospores – These are thick–walled aplanospres, e.g. *Vaucheria*, *Ulothrix*.

(d) Autospores – These are non–motile spores and resemble the parent cell in shape, e.g. *Chlorella*.

(iii) Sexual reproduction –

The cells produce gametes which after fusion form a zygote. The gametes are haploid cells and the zygote is a diploid structure. On germination a zygote divides by reduction division with the result that a new haploid plant is formed.

Other important information related to algae –

- Agar is obtained from the red algae *Gracilaria* and *Gelidium*.
- Agar is used as a culture medium for growing micro-organisms in the laboratory. It is also used in food and pharmaceutical industries.
- The unicellular alga *Chlorella* is rich in proteins and vitamins and is considered as a possible source of food for human beings.
- Carrageenan is obtained from the red alga *Chondrus crispus*. Carrageenan is used mainly in dairy industry. It is also used in cosmetics and pharmaceutical industries.
- Dynamite is prepared from the cell walls of fossil diatoms.
- Iodine is obtained from the brown algae, such as *Laminaria*.
- An antibiotic chlorellin is obtained from *Chlorella*.
- The green alga *Acetabularia* has been used in experiments to determine the role of nucleus in cellular control processes.
- The green alga *Chlorella* has been used to study certain processes in photosynthesis.
- *Cephaleuros virescens* parasitizes tea plants and produces the disease '"red rust".
- Water blooms on the surface of stagnant water are formed by excessive growth of some blue–green algae, such as *Anabaena, Microcystis, Oscillatoria* etc.
- 'Red snow' is caused by *Chlamydomonas nivalis*.
- F.E. Fritsch is considered as the 'Father of Phycology'.
- M.O.P. Iyenger is called as the 'Father of Indian Phycology'.
- The use of blue–green algae in the nitrogen economy of Indian agriculture was described by R.N. Singh.
- *Anabaena azollae* cells live as endophyte in fronds of *Azolla* (a pteridophyte), *Anabaena cycadae* in coralloid roots of *Cycas* (a gymnosperm), and *Nostoc* in the thallus of bryophyte *Anthoceros*.
- The blue–green algae are also known as cyanobacteria.
- Many filamentous blue–green algae, namely *Anabaena*, *Nostoc*, *Aulosira* are known to fix atmospheric nitrogen in Indian rice fields.
- The blue–green alga *Spirulina* is nutritionally very rich as it contains a high percentage of proteins, amino acids and vitamins.
- That part of the Mediterranian sea in which the blue–green alga *Trichodesmium* grows profusely is called the 'Red sea'. It is due to the presence of red phycoerythrin in the cells of *Trichodesmium*.
- The brown alga *Sargassum* grows abundantly in the Sargasso sea of the Atlantic.
- Potash is obtained from species of *Macrocystis* and *Nereocystis*.
- A convenient and widely–accepted classification of algae is by Fritsch.
- Silica is found in the cell walls of diatoms.

- *Macrocystis* is the largest algae. It is a member of Phaeophyceae.
- The primitive class in algae is Cyanophyceae and the advanced class is Rhodophyceae.
- Linnaeus for the first time used the term 'algae'.
- The filamentous blue–green algae contain specialized cells, called heterocysts. These are the sites of nitrogen fixation.

Characteristics of some algal groups

S.N.	Class	Common name	Main pigments	Reserve food	Pyrenoids	Flagella	Sexual reproduction	Examples
1.	Cyanophyceae	Blue-green algae	Chl. a, β-carotene myxoxanthophyll, c-phycocyanin, c- phycoerythrin	Glycogen, Cyanophycin	Absent	Absent	Absent	*Oscillatoria, Nostoc*
2.	Chlorophyceae	Green algae	Chl. a, Chl. b, β-carotene, Lutein	Starch	Present	2 or more, equal	Iso, aniso & oogamous	*Ulothrix, Spirogyra*
3.	Xanthophyceae	Yellow-green algae	Chl. a, Chl. c, β–carotene, xanthophylls	Oil, Leucosin	Present	2, unequal	Isogamous	*Vaucheria*
4.	Bacillariophyceae	Diatoms	Chl. a Chl. c, β–carotene, fucoxanthin, diatoxanthin	Oil, chryso-laminarin	Present	1, hairy	Iso and oogamous	*Pinnularia*
5.	Phaeophyceae	Brown algae	Chl. a, Chl. c, fucoxanthin, violaxanthin, β-carotene	Laminarin, Mannitol	Present	2, unequal	Iso, aniso & oogamous	*Ectocarpus, Sargassum*
6.	Rhodophyceae	Red algae	Chl. a, β- carotene, taraxanthin, r-phycoerythrin, r-phycocyanin	Floridean starch	Present in Bangio–phyceae	Absent	Oogamous	*Batracho-spermum, Polysip-honia*

- **Common names of some algae are as follows –**

Chara – Stonewort

Chlorella – Space alga

Hydrodictyon – Water net

Laminaria – Kelp

Macrocystis – Giant kelp

Chondrus – Irish moss

Spirogyra – Pond silk

Ulva – Sea lettuce

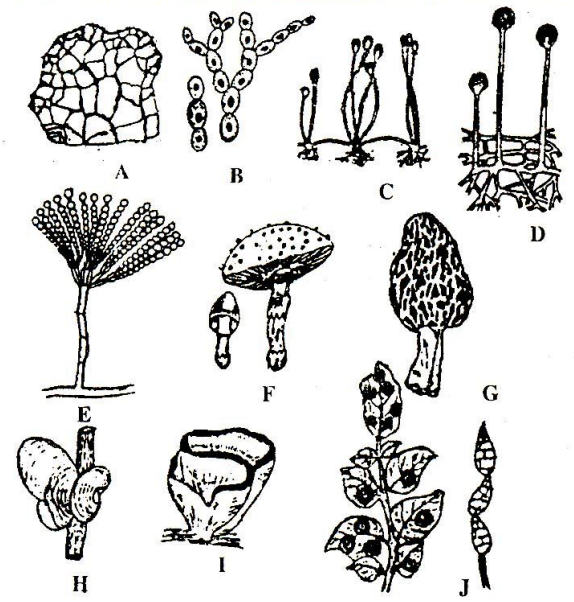
(II) FUNGI

The branch dealing with the study of fungi is called 'mycology'.

'Fungus' is a latin term that means 'mushroom'.

Important Characteristics of Fungi

1. Fungi do not have chlorophyll and therefore they do not prepare their own food material. They have to obtain it from external sources–either from dead organic matter (saprophytes) or from other living plants and animals (parasites). Some fungi have symbiotic relationship with other plants.
2. The thallus is made up of thin, long, branched filaments called 'hyphae'. The mass of hyphae is termed as 'mycelium'.
3. Except slime molds all other fungi have cell walls. The cell wall is made up of chitin. In the class Oomycetes the cell wall is of cellulose.
4. The fungi lack chlorophylls but have carotenoids.
5. The hyphae may be septate or aseptate. The aseptate hyphae have nuclei scattered in cytoplasm. This condition is known as coenocytic. However, in such hyphae, septa are formed at the time of formation of reproductive organs or in older portions of hyphae.
6. Some common examples are *Physarum* (slime mold), Yeast, *Rhizopus* (black mold), *Mucor, Penicillium* (green mold), *Agaricus* (mushroom), *Morchella, Polyporus* (bracket fungus), *Peziza, Alternaria* (imperfect fungus).



Different type of fungi

A. *Physarum* (slime mold), B–Yeast, C–*Rhizopus* (black mold), D–*Mucor,* E–*Penicillium* (green mold), F–*Agaricus* (mushroom), G–*Morchella,* H–*Polyporus* (bracket fungus), I–*Peziza,* J–*Alternaria* (imperfect fungus).

7. In fungi reproduction is of three types – vegetative, asexual and sexual.
8. **Vegetative reproduction**

   (i) Fragmentation – A small part of the broken hypha develops into a new thallus e.g., *Mucor*, *Aspergillus*.

(ii) Fission – The Cell divides in transverse plane into two cells e.g. fission yeasts.

(iii) Budding – When the cell develops bud–like small protuberances e.g. budding yeasts.

9. **Asexual Reproduction**

(i) Sporangiospores – These are formed inside the sporangium on a sporangiophore. The sporangiospores may be motile or non–motile. The non–motile sporangiospores are called aplanospores.

(ii) Conidiospores – The conidiospores are formed externally on the tips or sides of specialized hyphae, called conidiophores.

10. **Sexual Reproduction**

Except Deuteromycetes, sexual reproduction is found in other classes of fungi. Sexual reproduction involves fusion of two dissimilar nuclei.

11. The reserve food material in fungi is glycogen which is soluble polysaccharide. Glycogen is also found in animal cells and hence called as animal starch.

Other important information related to fungi

- Yeasts and *Synchytrium* are unicellular fungi.
- *Albugo* and *Mucor* are aseptate, coenocytic fungi.
- An example of slime molds is *Plasmodium*.
- Sexual reproduction (perfect stage) is not found in members of Deuteromycetes. Therefore, these are called 'Fungi imperfecti'.
- Coprophilous fungi (e.g. *Pilobolus*) grow on dung.
- The phenomenon of heterothallism was discovered by A.F. Blakeslee in *Mucor mucedo*.
- The study on annual recurrence of rust disease on wheat was made by K.C. Mehta.
- *Agaricus campestris* is the most commonly cultivated mushroom. Its fruiting bodies form 'fairy rings.'
- Yeasts are the rich source of vitamin B complex.
- The 'wonder drug' penicillin was discovered by Alexander Fleming (1929) from *Penicillium notatum*.
- *Neurospora* has been used in genetic research and is rightly called as '*Drosophila* of plant kingdom.'
- The growth hormone gibberellic acid is isolated from *Gibberella fujikuroi*.
- Yeasts are used in bread and wine industry on account of their ability to ferment sugar.
- Some species of *Morchella* and mushrooms are edible.
- *Claviceps purpurea* cause 'ergot disease' in rye, wheat, oat and barley.
- The hallucinogenic drug 'LSD' is obtained from *Claviceps purpurea*.
- Some species of fungi produce toxic substances called 'aflatoxins.'
- E.J. Butler is considered to be the 'father of Indian mycology and plant pathology.'
- The smut disease is caused by *Ustilago* and rust disease by *Puccinia*.

- ‘Foot ringworm’ or ‘Athletes foot’ is caused by *Trichophyton interdigitale*.
- The severe famine of Ireland in 1845 was due to the disease ‘late blight of potato’.
- Lomasomes found in between the cell wall and the plasma membrane are in the form of particles, vesicles or tubules.
- Chitin is a polymer made up of N–acetyl glucosamine units.
- Species of *Polyporus* are called wood–rotting fungi (lignicolous).
- Some species of *Penicillium* are used in the production of cheese.

Some fungi are also known by their common names as given under :–

Botanical name	**Common name**
Saccharomyces cerevisiae	Baker’s and brewer’s yeast
Aspergillus niger	Weed of the laboratory
Agaricus	Mushroom
Lycoperdon	Puffball
Mucor	Pin mold
Peziza	Cup fungus
Penicillium	Blue mold
Polyporus	Bracket fungus
Rhizopus	Green mold
Pilobolus	Shot–gun fungus

- Species of *Mucor*, *Rhizopus*, and *Aspergillus* spoil all types of foodstuffs.

Some of the important plant diseases caused by fungi are as follows :–

Disease–producing fungus (Pathogen)	**Disease**
Albugo candida	White rust of crucifers
Phytophthora infestans	Late blight of potato
Puccinia graminis tritici	Black rust of wheat
Alternaria solani	Early blight of potato
Helminthosporium oryzae	Brown leaf spot of rice
Cercospora personata	Leaf spot (Tikka disease) of groundnut
Colletotrichum falcutum	Red rot of sugarcane

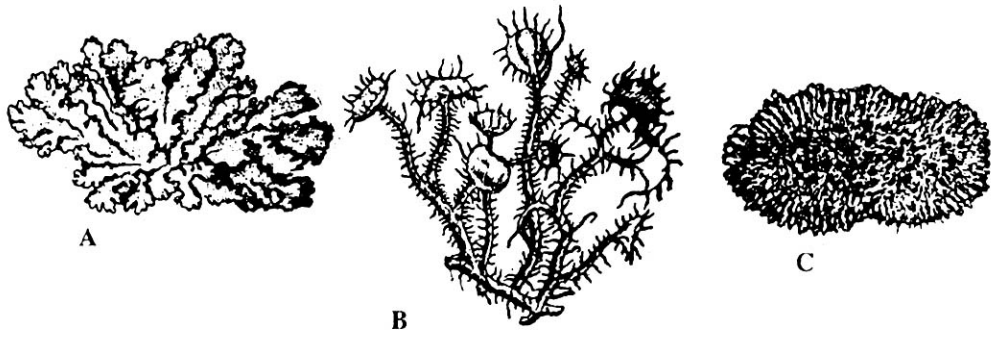
(III) LICHENS

1. Theophrastus first used the word ‘lichen’ for extra plant growth on tree–barks. The study of lichens is called ‘Lichenology’.

2. Lichen is a composite thalloid structure, made up of an alga and a fungus.
3. The algal component of a lichen is called a phycobiont, and the fungal component is called a mycobiont.
4. The algal component is usually a member of Cyanophyceae or Chlorophyceae. The fungal component is usually a member of Ascomycetes, rarely of Basidiomycetes.
5. The algal and fungal partners are benefited by this association (symbiosis or mutualism). The fungus derives nutrition from the alga, while the alga is protected from desiccation by the fungus.
6. Lichens can tolerate extremes of climate and are found everywhere ranging from hot deserts to cool mountains.
7. Lichens are generally grouped into three morphological categories.

   (i) Crustose – These occur as crusts over rocks, soil or tree barks, e.g. *Rhizocarpon, Graphis*.

   (ii) Foliose – These are leaf–like lobed structures attached to the substratum by means of special rhizoid–like organs, e.g. *Parmelia*, *Peltigera.*



Different types of lichens
A–Foliose (*Parmelia*), B–Fruticose (*Usnea*), C–Crustose (*Graphis*)

   (iii) Fruticose – These are shrub–like, cylindrical, erect lichens attached to the substratum by their basal ends e.g. *Cladonia*, *Usnea*.

Other important information related to lichens

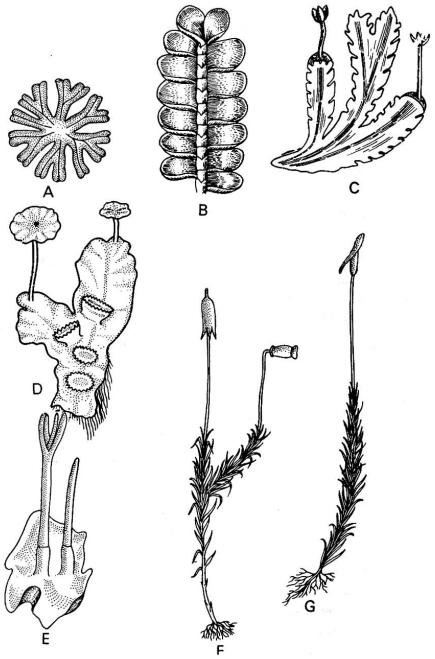
- The chemical indicator 'litmus' is derived from species of *Roccela* and *Lecanora*.
- *Cladonia rangiferina* is called 'reindeer moss'.
- *Peltigera canina* is useful in the cure of hydrophobia (dog–bite).
- Lichens are susceptible to presence of SO_2 in the air.
- Lichens are useful in the formation of soil and are called as 'farmers of nature'.

(IV) BRYOPHYTES

The branch dealing with the study of bryophytes in called 'Bryology'. The bryophytes are also called as Atracheata as they do not possess vascular tissues.

F.Cavers is considered as the 'Father of Bryology', while S.R. Kashyap is considered as the 'Father of Indian Bryology'.

1. Among the Embryophyta, bryophytes are the most simple and primitive plants.
2. The dominant phase in the life cycle is gametophyte.
3. The gametophyte is independent and is concerned with sexual reproduction. The sporophyte is dependent on the gametophyte for its nutrition.
4. The plant body is either thalloid (e.g. *Riccia*, *Anthoceros*) or leafy (e.g. *Porella*).
5. The plant remains attached to the substratum by delicate, hair–like organs, called rhizoids. In Hepaticopsida and Anthocerotopsida, the rhizoids are unicellular and unbranched. In Bryopsida the rhizoids are branched and multicellular.
6. The bryophytes lack the vascular tissues and hence are known as non–vascular embryophyta.
7. The bryophytes reproduce through vegetative and sexual methods.
8. The methods of vegetative reproduction are fragmentation, gemma formation and by the production of tubers, adventitious branches and protonema.
9. The sexual reproduction is oogamous. The sex organs are surrounded by a sterile jacket and are multicellular. The male and female sex organs are called antheridia and archegonia, respectively.
10. An antheridium produces biflagellate, motile antherozoids. An archegonium has a flask–shaped structure with a swollen venter and a long, narrow neck.
11. Water is essential for fertilization.
12. The sporophyte is divided into foot, seta and capsule, but in *Riccia* foot and seta are absent.
13. Some common example are *Riccia, Lejeunea*, *Pellia*, *Marchantia*, *Anthoceros, Polytrichum*, *Barbula*.



Different forms of Bryophytes A. *Riccia,* B. *Lejeunea*, C.*Pellia*, D. *Marchantia*, E. *Anthoceros,* F. *Polytrichum*, G. *Barbula*.

Other information related to bryophytes

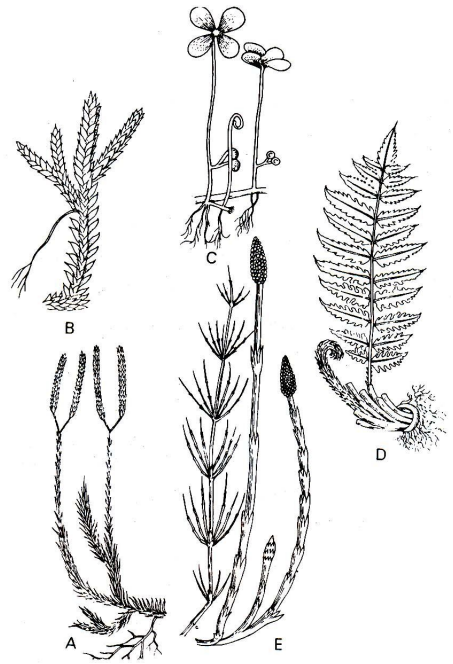
- Bryophytes are considered as 'amphibians of the plant kingdom'.
- The alternation of generations in the life cycle of Embryophyta was first observed by Hofmeister in 1851.
- The aquatic bryophytes are – *Riccia fluitans*, *Ricciocarpus natans*, *Sphagnum* and *Fontinalis*.
- Haploid spores are formed by meiosis from sporogenous cells in capsule. The spores are homosporous.
- A protonema is formed after germination of the spore.
- *Sphagnum* is known as peat moss or bog moss.
- The largest bryophyte is perhaps *Dawsonia* which reaches the size of 50–70 cm.
- Bryophytes are considered to be the first land–inhabiting plants.
- *Sphagnum* grows in swampy areas.
- *Sphagnum* is most important from economic point of view.
- In the second world war, *Sphagnum* was used as dressing cotton for wounds.
- 'Peat' is obtained from *Sphagnum*.
- *Riccia* and *Marchantia* are known as 'liverworts'. *Funaria* is known as green moss.

(V) PTERIDOPHYTES

1. Pteridophytes are also known as vascular cryptogams.
2. The main plant is a sporophyte which is independent and long–lived.
3. The plant is divided into root, stem and leaf. Some primitive members lack a true root e.g. Psilophytales and Psilotales.
4. The stem is dichotomously branched.
5. Pteridophytes can be divided into two categories –

   (i) Megaphyllous, and (ii) microphyllous. In the former category the leaves are large and the stem is small e.g. ferns. In the latter category the leaves are small and the stem is large, e.g. *Equisetum*.
6. The sporophyte has vascular tissue. In ferns small meristeles are found. Companion cells are absent in phloem and vessels in xylem.
7. Except *Isoetes*, secondary growth does not take place in other pteridophytes.
8. Reproduction is asexual. It takes place by spores which are formed in sporangia.
9. The sporangia are borne either on the stem, or on the leaves, or in their axils.
10. The sporophylls may be scattered or may be clustered in definite structures, called cones or strobili, e.g. *Selaginella*. In some pteridophytes (e.g. *Marsilea*) the sporangia are produced within special structures, called sporocarps.
11. The sporangia are of two types according to the mode of development – eusporangium and leptosporangium. The eusporangium is found in most of the pteridophytes. It develops from several sporangial initials. The leptosporangium is found only in some cases (e.g. ferns) and develops from a single initial.

12. On germination the spore form haploid gametophytes or prothalli.
13. The sex organs are multicellular and surrounded by a sterile jacket. The antheridia may be embedded in the tissue of the gametophyte or may project from it. Each antheridium consists of large number of androcytes. Each androcyte gives rise to a single motile antherozoid.
14. Each archegonium is a flask–shaped structure, consisting of a basal embedded venter and a short neck. The venter contains an egg and venter canal cells.
15. Water is essential for fertilization. The embryo or new sporophyte develops from the diploid zygote.
16. Both apospory and apogamy are found in pteridophytes. The development of a sporophyte from gametophytic tissue without sexual fusion is called apogamy. The development of the gametophyte directly from the sporophyte without meiosis is called apospory.
17. Some common example are *Lycopodium*, *Selaginella*, *Marsilea*, *Dryopteris, Equisetum*, *Marsilea.*



Different types of Pteridophyta–A.*Lycopodium*, B. *Selaginella*, C. *Marsilea*, D. *Dryopteris,* E. *Equisetum*. *Marsilea*

Other important information related to pteridophytes

- Pteridophytes, gymnosperms and angiosperms are together called as Tracheophyta.
- The smallest pteridophyte is *Azolla*.
- Tree ferns such as *Cyathea* and *Lygodium* are large pteridophytes.
- The aquatic pteridophytes are *Azolla*, *Salvinia* and *Marsilea*.
- Heterospory is seen in *Selaginella* and *Marsilea*, indicating the origin of seed habit.
- *Osmunda regalis* is called 'Indian royal fern'.
- *Selaginella* is a resurrection plant.

➢ **Common names of some pteridophytes are –**

Adiantum – Walking fern

Selaginella – Club moss

Equisetum – Horsetail

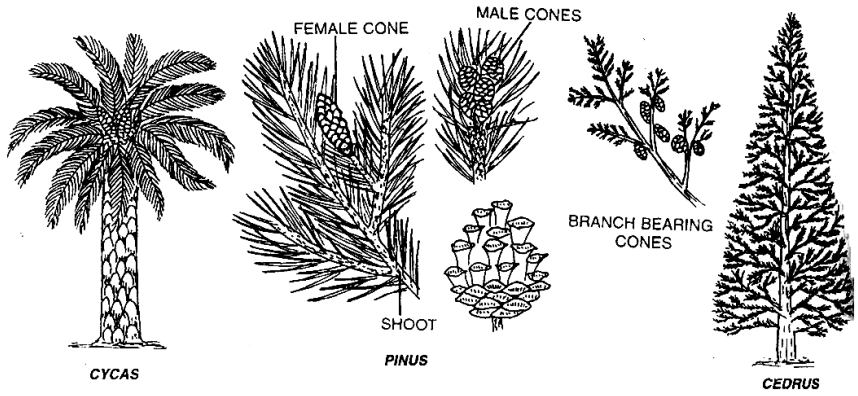
Isoetes – Quilwort

Pteridium – Sun fern

(VI) GYMNOSPERMS

The main characteristics of gymnosperms are as follows –

1. The ovules are naked.
2. Generally the plants are woody trees, shrubs and climbers. They are mostly xerophytic.
3. Plants have tap roots. Algal cell are present in the coralloid roots of *Cycas*. Roots of *Pinus* form mycorrhizal association with a fungus.
4. Stem is erect, branched (unbranched in *Cycas*) and woody with leaf scars.
5. Leaves are of two types – (i) green and pinnately compound foliage leaves. (ii) brown, scaly leaves.
6. Only tracheids with bordered pits are present in the xylem. Vessels are absent. Phloem lacks companion cells.
7. Vascular bundles are conjoint, collateral and open. Annual rings are present in the secondary wood. In *Pinus* the wood is densely packed and is called 'pycnoxylic'. In *Cycas* the wood is not so compact, and is called 'manoxylic'.
8. The sporophylls form cones. The male cone is small and short–lived, while the female cone is large and long–lived.
9. In male cone microsporangia are arranged on microsporophylls. Haploid microspores are formed in microsporangium.
10. Naked ovules are arranged on megasporophylls in female cone.
11. Ovules are orthotropous and unitegmic.
12. Pollination is through the agency of wind.
13. In gymnosperms, double fertilization or triple fusion is not observed.
14. The endosperm is haploid and is formed before fertilization.
15. In most of the cases, polyembryony (development of several embryos in a seed) occurs.



Some Gymnosperms.

Other important information related to gymnosperms

- *Sequoia semipervirens* = *gigantica* is the highest living tree of the world. It is also known as 'Coast redwood of California'.
- *Zamia pygmea* is the smallest living cycad.
- *Taxodium mexicanum* is perhaps the thickest gymnosperm. Diameter of its stem is about 17 metres.
- The living fossils are – *Cycas, Ginkgo biloba* and *Metasequoia*.
- 'Canada balsam', used in laboratories, is obtained from *Abies balsamea*.
- 'Ephedrine' is obtained from *Ephedra*.
- The 'chirwood' is obtained from *Pinus longifolia*.
- *Cycas revoluta* and *Metroxylon rumphii* yield 'sago'.
- 'Chilgoza' fruits are the seeds of *Pinus gerardiana*.
- *Ginkgo biloba* is called as 'maiden hair tree'.
- 'Cedarwood oil' is obtained from the heartwood of *Juniperus virginiana*.
- The naturally–growing gymnosperm in Rajasthan is *Ephedra*.
- **The common names of some gymnosperms are as follows :–**

  Cycas revoluta–Sago palm

  Pinus gerardiana–Chilgoza pine

  Pinus roxburghii = *P. longifolia* – Chir pine

  Pinus wallichiana = *P. excelsa* – Blue pine
- The wood of *Abies* and *Picea* is used in the manufacture of match–boxes and aircrafts.
- Paper is manufactured from the wood pulp of *Abies, Picea*.
- The pollen grains (microspores) of *Pinus* are winged.
- The coralloid roots of *Cycas* contain cells of a blue–green alga.

(VII) ANGIOSPERMS

1. It is most developed and dominant group of the plant kingdom.
2. The main plant is a diploid sporophyte, divided into roots, stems and leaves.
3. Plants are herbs, shrubs, trees, climbers and twiners.
4. These are flowering plants. Ovules develop within the ovary, with the result that seeds and fruits are formed.
5. Vascular bundles are well–developed. Vessels and companion cells are found in xylem and phloem, respectively.
6. Pollination occurs through various agencies.
7. The male gametophyte is reduced. Male gametes are non–flagellated.
8. Double fertilization is the rule in angiosperms.
9. Endosperm is formed after fertilization, as a result of triple fusion.

Other important information related to angiosperms

- The smallest angiosperm is *Lemna*, while the tallest one is *Eucalyptus*.
- *Wolffia* has the smallest flowers.
- *Rafflesia* bears the most gigantic flowers, about 50 cm. in diameter and weighing about 8 k.g.
- The largest leaves are those of *Victoria regia*.
- *Monotropa* (Indian pipe plant) is a total saprophyte.
- *Lodoicea maldivica* (double coconut) bears the largest two–lobed seeds.
- *Parthenium* is known as 'congress grass'.

BRANCHES OF BOTANY :

All branches may be divided into two categories : –

(i) Pure botany – In this category the structure and functions of plants are studied.

(ii) Applied botany – In this the plants are studied for their utility to mankind.

(i) PURE BOTANY

1. **Phycology or algology –** The study of algae.
2. **Mycology –** The study of fungi.
3. **Bryology –** The study of bryophytes.
4. **Pteridology –** The study of pteridophytes.
5. **Virology –** The study of viruses.
6. **Bacteriology –** The study of bacteria.
7. **Lichenology –** The study of lichens.
8. **Palynology –** The study of pollen grains.
9. **Agrostology –** The study of grasses.
10. **Dendrology –** The study of trees.

11. **Xylotomy –** The study of wood.
12. **Morphology –** The study of form and structure of plants.
13. **Anatomy –** The study of internal structure of plants.
14. **Ecology –** The study of relationships between living organisms and their environment.
15. **Plant embryology –** The study of formation of gametes, fertilization and embryo development.
16. **Paleobotany –** The study of formation of plant fossils and their external and internal structure.
17. **Plant pathology –** The study of pathogen, disease symptoms and its control.
18. **Phytogeography –** The study of distribution of plants on the earth.
19. **Histology –** The study of tissues.
20. **Genetics –** The study of heredity and variation.
21. **Economic botany –** The study of economically important products of plants.
22. **Plant taxonomy –** The study of identification, nomenclature and classification of plants.
23. **Cytology –** The study of internal structure and functions of cells and cell organelles.
24. **Plant physiology –** The study of vital activities of plants.
25. **Plant biochemistry –** The study of chemistry of plants.
26. **Plant biophysics –** The study of plant activities on the basis of principles of physics.
27. **Ethnobotany –** The study of use of plants by tribals.
28. **Heredity –** The study of inheritance of characters.
29. **Forestry –** The study of forests.
30. **Gymnology –** The study of gymnosperms.
31. **Evolution –** The study of the process whereby modern forms of life have developed from earlier similar forms.

(ii) APPLIED BOTANY –

1. **Agronomy –** The study of crop plants.
2. **Horticulture –** The study of garden plants.
3. **Pharmacognosy –** The study of medicinal plants.
4. **Pharmacology –** The study of the effects of medicines on living organisms.
5. **Plant breeding –** The study of improvement of crop varieties.
6. **Silviculture –** The study of forest trees and their products.
7. **Agroforestry –** The study of the effective use of the land for growing crops and trees.
8. **Molecular biology –** The study of biochemistry at molecular level.
9. **Arboriculture –** The study of culture of ornamental plants.
10. **Genetic engineering –** The study of transfer of genes from one organism to another.
11. **Microbiology –** The study of microorganisms.
13. **Pedology –** The study of formation, structure and conservation of soils.
14. **Tissue culture –** The development of a plant in the laboratory from a single cell, tissue or organ.

MYCOPLASMA

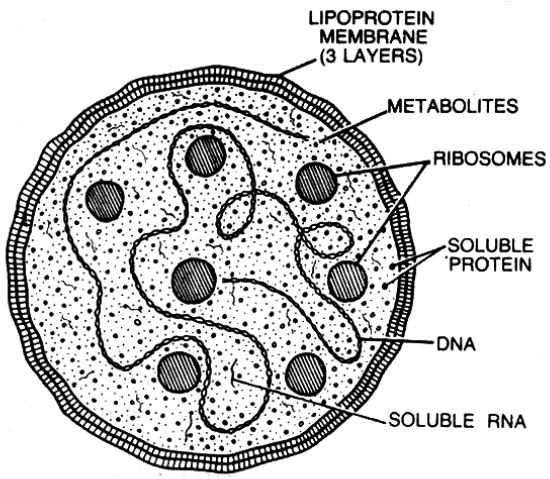
- Mycoplasmas (PPLO) were first discovered by E. Nocard and E.R. Roux (1898) during their work on bovine pleuropneumonia of cattles.
- They were named as Pleuropneumonia–like organisms (PPLO).
- Nowak (1929) later on gave them the generic name of Mycoplasma.
- Doi *et. al.* discovered mycoplasma in plants and named it MLO (mycoplasma like organism)

CHARACTERISTICS

- They are very simple, unicellular, procaryotic, non–motile and have very small size (e.g. 0.1 to 0.3 μm).
- They possess both DNA and RNA.
- They are resistant to antibiotics (such as penicillin).
- They are sensitive to tetracyclines, chloramphenicol, osmotic shock and detergent.
- They usually require sterol for their growth in culture medium.

STRUCTURE

- Mycoplasmas have true cells.
- It is bounded by a plasma membrane.
- The DNA molecule appears in form of fibrils or a single double helix and it is not enveloped by any nuclear membrane.



Mycoplasma showing structural details

- The nuclear region is surrounded by 70s ribosomes and other constituents.
- Like animal cells, they lack cell wall and have cytoplasmic membrane which is made–up of phospholipid and protein (Lipoprotein).
- They form fried egg shaped colony under culture conditions (on agar medium).

MYCOPLASMAL DISEASES :

Many mycoplasmas are pathogens of plants, human beings and animals. Some of the important diseases are given below :

(A) Plant diseases :

1. Little leaf of brinjal
2. Bunchy top of papaya
3. Witche's broom of legumes/groundnut
4. Sesame phyllody
5. Clover phyllody
6. Witche's broom of potato
7. Corn stunt
8. Sandal spike

(B) Human diseases :

1. *Mycoplasma hominiis* causes (Urithritis) inflammation of the reproductive organs of males and females. The disease is transmitted through sexual activity.
2. *Mycoplasma pneumoniae* causes mycoplasmal pneumonia (Primary Atypical Pneumonia = PAT). The pathogen usually infects the upper respiratory tract and then moves into the lower respiratory tract, where it attaches to respiratory mucosal cells. This disease is quite common in infants and small children.

(C) Animal diseases :

Pathogen	Disease
1. *Mycoplasma bovigenitalium*	Inflammation of genitals of animals
2. *M. mycoides*	Bovine pleuropneumonia
3. *M. agalactiae*	Agalactia of sheep, goat
4. *M. hyopneumoniae*	Pneumonia of pigs

BACTERIA

INTRODUCTION

- Dutch Scientist Antony Van Leeuwenhoek (1683) saw stored rain water, saliva and waste materials of teeth by his own manufactured single microscope. He saw "tiny animalcules" (microorganisms). He first discovered bacteria in stored rain water.
- Ehrenberg (1892) called them as Bacteria.

Characteristics

- Bacteria *(singular-bacterium)* are very small, simplest, single celled (unicellular), prokaryotic, primitive and living organisms.

- They are cosmopolitan and occur in water, soil, air, animals and plants.
- They may be spherical, elongated, rod-like and some are variously spiral.
- The bacteria have rigid cell wall composed of a substance called peptidoglycan (by contrast, cellulose is the main substance of plant and algal cell walls) outside the cell membrane.
- Some bacteria have one or many flagella. The flagella provide the power of movement to the bacteria.
- In the bacterial cells a well defined nucleus is not found. The nucleus does not have any nuclear membrane, nucleolus and chromosomes, like a typical eukaryotic cell and the histone proteins do not remain attached with the DNA helix.

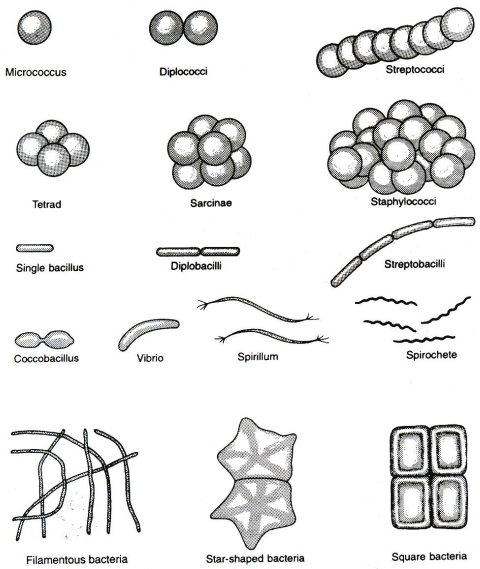
SIZE OF BACTERIA

- General length is (2 to 10 μ).
- Smallest known bacterium is *Dialister pneumonsintes* (0.15–0.3 μ).
- Largest known bacterium is a recently discovered bacterium *Epulopiscium fishelsoni* which is 0.3 mm long, (earlier *Spirillum volutans* is considered to be the largest bacteria).
- Largest filamentous bacteria–Beggiatoa.

SHAPES OF BACTERIA

- Bacterial cells generally appear in several shapes. Bacteria may form pairs, chains, clusters or other groupings.
- On the basis of their varying shapes and sizes the bacteria may be classified into several varieties as follows :

1. **Spherical or Cocci :** These bacteria are either oval or spherical in shape. They are the smallest bacteria. They may be of the following types.



Different forms of Bacteria

(i) **Monococcus :** When they live alone, *e.g., Micrococcus luteus*.

(ii) **Diplococci :** When they are found in pairs, *e.g., Diplococcus pneumoniae.*

(iii) **Streptococci :** When many cells remain attached to form a chain, e.g., *Streptococcus lactis*.

(iv) **Sarcinae** (Gr. Sarcina = Bundle) **:** When they live in a cube-like or cubical packet of 8, 64 or more, e.g., *Sarcina.*

(v) **Staphylococci** (Gr. *Staphyle* = cluster of grapes) **:** When they live in a group, in an irregular pattern, as grape-like cluster, *e.g., Staphylococcus aureus.*

2. **Bacilli** (singular, *bacillus*) **:** When they are rod–shaped This is derived from the Greek word, *Bacillum,* which means a stick in small rod. They are of the following types :

(i) **Single bacillus :** When only one rod-like structure represents the bacterium. This is most common type.

(ii) **Diplobacilli :** When they are found in pairs, *e.g., Bacillus subtilis.*

(iii) **Streptobacilli :** When they are found in a chain, *e.g., Bacillus anthracis.*

3. **Spirilli = Spirilla =** (singular, spirillum) (Gk. *speira* = coil) **:**

These are spiral shaped bacteria *e.g., Spirillum volutans.*

4. **Vibrio :** These bacteria are small and often curved, like a comma (,), *e.g., Vibrio cholerae* and *Vibrio comma*.

5. **Actinomycetes :** These are branched, filamentous fungi like bacteria. *e.g. Actinomyces, Streptomyces*.

6. **Pleomorphic :** A few bacteria occur in more than one shape, *e.g., Rhizobium* which makes identification of bacteria more difficult. These bacteria are termed pleomorphic (*pleo* = many), which means they can have many shapes, not just one.

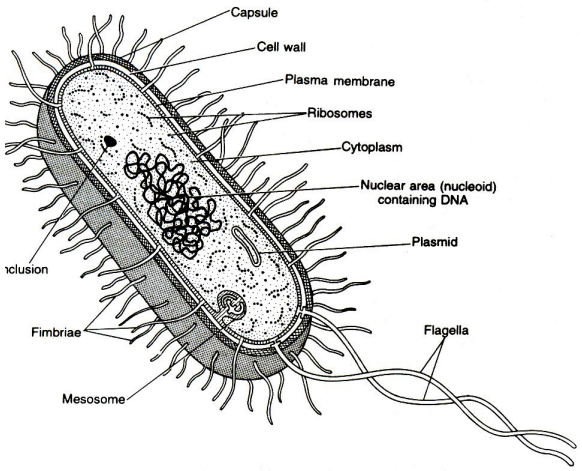
In recent years, investigators have described star-shaped bacteria of the genus *Stella*.

ULTRASTRUCTURE :

The structure of a general bacterial cell is shown in :

(1) Pili and Fimbriae

- Pili are superficial appendages which are smaller and narrower than flagella and are present in less numbers.
- These hair–like structures are formed of a protein, pilin.
- The Fimbriae help in adhesion of bacterial cells during conjugation or to some suitable substratum.
- The larger pili are called sex pili.



Electron microscopic structure of a typical bacterial cell

(2) Cell wall

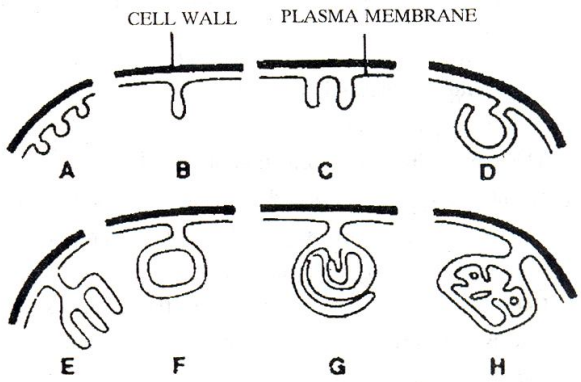
- The cell wall of bacteria is made of mucopeptides ; also known as peptidoglycan or murein.
- Mucopeptide is a polymer made up of alternating units of N–acetylglucosamine (NAG) and N–acetylmuramic acid (NAM).
- The amino acids are L–alanine, D–alanine, L–lysine and D–glutamic acid (in Gram–positive bacteria and actinomycetes).
- Lysine is replaced by diaminopimelic acid in Gram–negative bacteria and blue–green algae.

(3) Plasma membrane

- Cytoplasm remains surrounded by a plasma membrane made up of proteins and lipids.
- The space between cell wall and plasma membrane is known as periplasmic space.
- The plasma membrane is selectively permeable and allows particular atoms and molecules to pass, into or out of the cell, while preventing the movement of others.

(4) Mesosomes

- These are infoldings or invaginations of the plasma membrane.



Infoldings of plasma membrane (mesosome)

- It is thought that mesosomes are connected with DNA replication and septum formation in a dividing cell.

(5) Cytoplasm

- It contains 70S ribosomes which are usually found scattered.
- Membrane–bound organelles such as nucleus, chloroplast, mitochondrion, endoplasmic reticulum etc. are absent.
- Photosynthetic bacteria contain photosynthetic lamellae.
- The lamellae contain chlorophylls.

(6) Nucleoid

- The bacterial genome is a single circular double helical DNA molecule., DNA is not bound by histones.
- Due to the absence of a well-organised distinct nucleus, the genetic material is called nucleoid.
- In some bacteria "extra" pieces of circular DNA are also found. These are called plasmids.
- Plasmids are capable of autonomous replication and perform different functions.

  Plasmids which can integrate into bacterial DNA are called episomes.
- Some of the antibiotics obtained from different species of bacteria are given below :

Sr. No.	Name of antibiotic	Bacteria from which derived
1	Streptomycin	*Streptomyces griseus*
2	Chloromycetin (Chloramphenicol	*S. venezuelae*
3	Aureomycin (Chlortetracycline)	*S. aureofaciens*
4	Terramycin (Oxytetracycline)	*S. rimosus*
5	Neomycin	*S. fradiae*
6	Erythromycin	*S. erythraeus*
7	Kanamycin	*S. kanamyceteus*
8	Griseofulvin	*S. griesus*
9	Bacitracin	*Bacillus subtilis*
10	Polymyxin B	*Bacillus polymyxa*

(a) Human diseases caused by Bacteria

Sr. No.	Name of bacteria	Name of diseases
1	*Diplococcus pneumoniae*	Pneumonia
2	*Clostridium tetani*	Tetanus or lock jaw
3	*Clostridium botulinum*	Botulism (food poisoning)
4	*Eberthella typhosa* (=*Salmonella typhi*)	Typhoid fever
5	*Corynebacterium diphtheriae*	Diphtheria
6	*Mycobacterium tuberculosis*	Tuberculosis (TB)
7	*Neisseria meningitidis*	Meningitis
8	*Neisseria gonorrhoeae*	Gonorrhea
9	*Haemophilus pertussis* (*Bordetella pertussis*)	Whooping cough (Pertussis)
10	*Vibrio cholerae*	Cholera
11	*Pasteurella pestis* (*Yersinia pestis*)	Plague
12	*Treponema pallidium*	Syphilis
13	*Shigella dysenteriae* (*Bacillus dysenteriae*)	Bacterial dysentery also known as Shigellosis
14	*Salmonella typhimurium*	Bacterial food poisoning
15	*Mycobacterium leprae*	Leprosy
16	*Staphylococcus aureus*	Fever, lowered blood pressure, vomiting, and diarrhoea
17	*Bacillus anthracis*	Anthrax
18	*Bacillus coli*	Diarrhoea
19	*Escherichia coli*	Gastroentritis
20	*Streptococcus sp.*	Rheumatic fever

(b) Animal diseases –

S.No.	Animal Diseases	
	Disease	Bacteria
1	Anthrax (Cattle, Sheep)	Bacillus anthracis
2	Black Leg (Cattle, Sheep)	Clostridium Chanvei
3	Brucellosis (Cattle, Pig, Goat, Also human undulant, mediterranean or malta fever)	Brucella melitensis, B.seuis
4	Abortion (Domesticated Animals)	Salmonella abortus-ovis
5	Listerosis (Sheep, Calf, Chicken)	*S.dublin Monocotygenes species*
6	Plague	*Yersinia pestis (Pasteurella pestis)*

(c) Plant diseases

S.No.	Plant Diseases	+
	Disease	Pathogen
1	Soft Rot of Turnip & Carrot	Erwinia carotovora
2	Fire Blight of Apple, Pear	Erwinia amylovora
3	Bacterial Blight of Rice / Paddy	Xanthomonas oryzae
4	Angular Leaf Spot of Cotton	Xanthomonas malvacearum
5	Leaf Spot of Capsicum	Xanthomonas vesicatora
6	Citrus Canker	Xanthomonas citri
7	Tundu (Ear Rot of Wheat)	Corynebacterium tritici
8	Crown Gall	Agrobacterium tumefaciens

VIRUSES

INTRODUCTION

- Pasteur (1892) used the term 'virus' for the first time. In Latin the term means "poison".
- Stanley (1935) isolated and crystallized tobacco mosaic virus and was awarded the Nobel Prize.

NATURE AND CLASSIFICATION

- Viruses are very small acellular and infectious particles which can be seen only by an electron microscope.
- They cannot be grown on the artificial media.
- They do not contain cytoplasm.
- They behave as living organisms inside the host tissue only where they can multiply.
- Viruses lack functional autonomy.
- Viruses can be easily crystallized.
- They are not affected by antibiotics but can be made inactive by chemo and thermotherapy.
- They contain only one type of nucleic acid (either RNA or DNA) and a protein covering.
- A complete virus particle which has infectious power is called a "virion".

(A) Animate (living) characters of viruses

- They possess genetic material, either DNA or RNA.
- They can multiply and mutate.
- They show host specificity.

- They react to stimuli such as light, radiations, chemicals, heat etc.

(B) Inanimate (non–living) characters of viruses

- Viruses lack cell wall, cell membrane, cell organelles and protoplasm.
- They do not respire or grow.
- They are inert like a chemical outside the host.
- They lack functional autonomy.

SHAPE AND SIZE

- The smallest plant virus is statellite tobacco mosaic virus, measuring about 17 nm.
- Among animals, pox viruses are the largest (400 nm).
- The smallest animal virus is foot and mouth virus of cattle, measuring about 10 nm.
- Viruses consist of a core of nucleic acid, either DNA or RNA, held within a protein coat called capsid. The capsids are constructed of ring–or knob–shaped units called capsomers.
- Viruses have all four possible nucleic acid types : single–stranded DNA, double–stranded DNA, single–stranded RNA, and double–stranded RNA. All four types are found in animal viruses (Animal viruses generally have DNA). Plant viruses generally have single–stranded RNA. Bacterial viruses usually contain double–stranded DNA.

VIRAL DISEASES

Viruses produce diseases in plants, animals and human beings. Some of the common diseases are given below:

Plant diseases

- Tobacco mosaic
- Sandalwood spike
- Sugarcane mosaic
- Bean mosaic
- Aster yellow
- Bunchy top of banana
- Leaf curl of papaya
- Potato mosaic
- Tomato mosaic
- Cauliflower mosaic
- Wheat mosaic
- Little leaf of Brinjal
- Papaya mosaic
- Potato leaf roll

Animal diseases

- African horse sickness
- Foot and mouth disease of cattle
- Virus pneumonia of pigs
- Rabies of dogs and cats

Human diseases

- Influenza
- Measles
- Dengue fever
- Small pox
- Common cold
- Yellow fever
- AIDS
- Chicken Pox
- Herpes

Type of nucleic acid	Examples
Single–stranded DNA	ϕ x 174, fd phages
Double–stranded DNA	T–coliphages, lambda phages and other bacteriophages, herpes viruses, adeno viruses, polyoma virus, cauliflower mosaic virus.
Single–stranded RNA	Polio virus, RNA bacteriophages, TMV and most plant viruses, retro viruses, rabies virus, mumps virus, meales virus.
Double–stranded RNA	Reo viruses, wound tumor virus, myco viruses

IMPORTANT COMPETITION TIPS

LIVING WORLD

1. **Waterlily** has 81 Dutch names, 44 French names and 15 English names.
2. **Atharva Veda** mentions 108 plants with powers to heal wound, skin grafting, hair growth, increased milk yield, bone setting etc.
3. **Hippocrates (462 - 370 B.C.)** is known as father of medicine.
4. **Species** is the basic unit of taxonomy.
5. The fossil study shows that earlier simpler organisms gradually evolved into complex ones. The earliest fossils, about 3.1 billion years old, resemble the existing bacteria.
6. The date on which species name was published may also be added to the scientific name e.g. ***Homosapiens*** **Linn. 1758.**
7. Biological classification is not rigid and is subject to modification as more and more is learnt about organisms.
8. If both generic and specific names are same, these are called **tautonyms.**
9. **Bentham** and **Hooker** gave the first natural classification of plants.
10. **Monograph** is a book or essay which gives comprehensive account of all available information about a genus, family or higher category of grouping at the time of its publication.

VIRUSES

1. **Interferons : (Isaacs and LIndenmann, 1957)**. Interferons are antiviral proteins (a class of glycoproteins) which diffuse out from infected cells, enter into the cells in the neighbourhood and impart a defence mechanism to these cells against viral infections by inhibiting the synthesis of viral proteins. These are therefore used for therapeutic and preventive purposes in viral infections.
2. **Pox viruses** are among the **largest of animal viruses**.
3. In lysogenic cycle the viral genome gets incorporated into bacterial DNA and replicates along with it. Bacterial cells carrying viral genome are called lysogenic bacteria.
4. Viruses attacking blue–green algae are called **cyanophages**. They were discovered by **Safferman and Morris (1963)**. **The cyanophage LPP–1 attacks the blue–green algae, Lyngbya, Phormidium, and Plectonema.**
5. Viruses attacking mushrooms, Penicillium and other fungi are called **mycophages**.
6. Viral vaccines can be produced by cultivating viruses on animal tissues, chick embryo etc.
7. Cells infected by viruses produce **interferons**. They spread to neighbouring cells and make them resistant to viral infection. The term **'interferon'** was proposed by **Issacs and Lindermann (1957)**.
8. **Cyanophages (LPP–1) are used for controlling algal blooms.**
9. Viral strains are cultured and used as vaccines against certain diseases.
10. **S.Prusnier** was awarded nobel prize in 1997 for his contribution to infectious agents called **Prions** which are made up of proteins without any nucleic acids.

MONERA

1. *Escherichia coli* is the **most studied** bacterium.
2. **Teichoic acid** present in the cell walls of bacteria binds **Magnesium ions** and protects bacteria from **thermal** injuries.

3. A **mycoside (6, 6-dimycolyl threhalose)** - also called **cord factor** is derived from mycolic acid, and plays an important role in the diseases caused by *C. diphtheriae* and *M. tuberculosis.*

4. *Bdellovibrio bacteriovorus* represents **bacteria predatory upon other bacteria.** It purifies the water of river Ganges.

5. The metabolic and physiological roperties of **pseudomonade** are characterised by the wide **spectrum of substrates** these can use. They can even utilise a large number of organic **heterocyclic** and **aromatic** compounds (natural/man-made) which are not attacked by other bacteria. This property has been used to reduce pollution e.g. from petroleum spillage.

6. At University of illinois **Prof. Anand Mohan Chakraborty,** (an India born molecular biologist) and his coworkers (1979) developed a superstrain of *Pseudomonas* which can degrade oil.

7. **Actinomycetes** (actis = ray; mytes = fungus) i.e. **ray fungl** belong to order **Actinomycetales** of bacteria. These are **prokaryotic but consist of a mycellium which resembles a mass of branched, thin, non-septate filaments-hyphae.**

8. If kept under conditions favouring bacterial growth, raw milk develops a clean sour flavour mainly due to fermentation of lactose to lactic acid by *Streptococcus lactisl S. cremoris*/ and some otehr lactobacill. But as acidity increases, these species are inhibited and these are replaced by acid-duric bacteria called **lactics.** (e.g. *Lactobacillus, Leuconostoc*). As the acidity reaches **4.7,** curdling occurs.

9. A variety of the **enteric** group of bacteria (facultative, aerobic) reside in the human large intestine (e.g. *E. coli*). therefore, if they are present in water supply, you can guess that water supply has been contaminated by sewage.

10. Some enteric bacteria produce **toxins** leading to intestinal diseases (cholera, typhoid).

FUNGI & LICHEN

1. Micheli **(1728) described 300 species of Lichen.**

2. **Dual nature of Lichen was studied by** Schwendener (1897)

3. Ahmadjian (1963) **considers fungus to be a controlled parasite. The phenomen on of controlled parasitism is called** Helotism**.**

4. The fungi growing on tree bark, dung, wood, burnt wood and keratinaceous materials (e.g., hair) are called **carticolous, coprophilous, eplxylic, xyllophilous** and **KeratInophilic** respectively.

5. The fungi which tolerate very dry atmospheric condtions are called xerophilic.

6. The fungi growing inside host tissues are **endophytic.**

7. The **predacious** fungi (which capture small animals–protozoa, nematodes etc.) develop a number of structures called **traps** for capturing their preys e.g. Arthrobotrys, Dactylaria.

8. **Rhizomorphs** are thick strands of somatic hyphae in which hyphae aggregate so much that they lose their individuality, behaving as an organised unit. These grow apically as well as branch like an apical meristem of the root apex of higher plants (hence called **rhizomorph**).

9. In some fungi, hypae aggregate to form hard, compact, pseudoparenchymatous resting stuctures called **sclerotia.**

10. An **acervulus** is a flat/saucer-shaped structure produced on the plant tissues under the epidermis/ cuticle consisting of a mat of hyphae giving rise to short conidiophores closely packed forming a cushion-like mass.

PLANTAE KINGDOM

1. **R. N. Singh** is known for his researches on N_2 - fixation by blue - green algae.

2. *Spirogyra* was first observed by **Link.**

3. **P. K. De** attracted attention to the N_2-fixing ability of blue-green algae.

4. In algae belonging to order Oedogoniales (Chlorophyceae) e.g., *Oedogonium*, cap cells are formed as a result of cell division.

5. **Distinct grana** are formed in the chromatophores of **green algae** and some other algae (prasinophytes), but are not formed in the chromatophores of algae belonging to other classes.

6. All green algae possess pyrenoids. In other classes, some members may lack pyrenoids. Thus, these are integral parts of chromatophores in many algae. However, pyrenoids are completely absent in blue green algae.

7. **Oedogonium :** has ring like markings called cap cells. These cap cells are capable of division, sexual reproduction is oogamous. It is of two type.

   (a) Macrandrous : Antheridia produce normal sized filament

   (b) Nannadious : Antheridia produce special dwarf male filament called nannandria.

8. **Smallest Bryophytes** - *Zoopsis* and *Legeunea* (microscopic).

9. **Largest Bryophytes** - *Dawsonia* reaching upto 70 cm (found in New Zealand and Australia).

10. **Saprophytic bryophyte -** *Buxbaumia aphylla* (grows upon rotten wood).

11. **Sphagnol** used is for skin disorders extracted from ***Sphagnum.***

12. Elaters exhibit **xerochasy.**

13. ***Riccia fluitans, Riella*** and ***Ricciocarpus*** are aquatic bryophytes.

14. ***Funaria*** is also known as cord moss.

15. **Psilophytales** (now extinct) are believed to be first land vascular plants. ***Rhynia*** is a fossil plant grouped under Psilophytales.

16. ***Azolla i***s known as **water ferm** (an aquatic fern used as biofertiliser).

17. **Heterospory** is a character of evolutionary significance because seed habit (characteristic feature of gymnosperms and angiosperms) and differentiation of spores on the basis of sex is believed to have originated from heterosporous condition.

18. ***Cyathea*** and ***Alsophila*** are **tree ferns.** *Alsophila* is tallest ferm.

19. ***Salvinia*** is an aquatic pteridophyte weed.

20. In some gymnosperms e.g., *Ephedra*, only scaly leaves are present.

21. Males cones of gymnosperms are usually **short-lived.**

22. In Gnetales, the ovules are **bitegmic.**

23. Male gametes of *Cycas* and *Ginkgo* are motile.

24. The embryo is **endoscopic** and there is tendency of **polyembryony.**

25. ***Ginkgo biloba*** is also known as a living fosil.

LIVING WORLD, FUNGI & PLANT KINGDOM (EXERCISE-1)

Q.1 Moss peristome takes part in –
[1] Spore dispersal [2] Photosynthesis [3] Protection [4] Absorption

Q.2 In *Pinus/gymnosperms,* the haploid structure are –
[1] Megaspore, endosperm and embryo [2] Megaspore, pollen grain and endosperm
[3] Megaspore, integument and root [4] Pollen grain, leaf and root

Q.3 Spermatozoid of *Cycas* is –
[1] Biflagellate [2] Nonflagellate [3] Uniflagellate [4] Multiflagellate

Q.4 In pteridophytes/Dryopteris meiosis occurs at the time of –
[1] Gamete formation [2] Spore formation
[3] Formation of prothallus [4] Formation of sex organs

Q.5 *Cycas revoluta* is –
[1] Date Palm [2] Sea Palm [3] Royal Palm [4] Sago Palm

Q.6 Wood of *Cycas* is –
[1] Monoxylic and manoxylic [2] Manoxylic and polyxylic
[3] Diploxylic [4] Monoxylic

Q.7 Pigments common to all algae are –
[1] Chlorophyll *a* and phycobilins [2] Chlorophyll *a* and carotenoids
[3] Chlorophyll *a* and chlorophyll b [4] Chlorophyll *b* and carotenoids

Q.8 Thin–walled nonciliate and nonmotile asexual spores are –
[1] Akinetes [2] Hypnospores [3] Hormogonia [4] Aplanospores

Q.9 Formation of gametophyte directly form sporophyte is –
[1] Apogamy [2] Apospory [3] Apocarpy [4] Parthenogenesis

Q.10 Largest spermatozoids are those of –
[1] *Pinus* [2] *Selaginella* [3] *Dryopteris* [4] *Cycas*

Q.11 In *Cycas,* pollination is by –
[1] Wind [2] Insect [3] Water [4] Both 1 and 2

Q.12 Independent alternation of generations is present in –
[1] Angiosperms [2] Gymnosperms [3] Pteridophytes [4] Bryophytes

Q.13 Fern gametophyte is –
[1] Multicellular, cordate prothallus [2] Liver-shaped thallus
[3] Unicellular, colourless [4] Filamentous, multicellular and green

Q.14 Parasitic alga is/Tea and Coffee leaves are infected by –
[1] *Cephaleuros* [2] *Sargassum* [3] *Oedogonium* [4] *Ulothrix*

Q.15 In chlorophyceae, sexual reproduction occurs by –
[1] Isogamy and anisogamy [2] Isogamy, anisogamy and oogamy
[3] Oogamy only [4] Anisogamy and oogamy

Q.16 Male cone of *Pinus* is made of –
[1] Anthers [2] Ligules [3] Microsporophylls [4] Megasporophylls

Q.17 The number of peristome teeth in *Funaria* capsule is –
[1] 8 [2] 16 [3] 32 [4] 64

Q.18 Moss plants develop from –
[1] Oospores [2] Protonema [3] Antherozoids [4] Diploid spores

Q.19 Fern plant is –
[1] Diploid sporophyte [2] Diploid gametophyte
[3] Haploid sporophyte [4] Haploid gametophyte

Q.20 Well developed archegonium with neck having 6 and 4 rows of neck cells occurs in –
[1] Pteridophytes and gymnosperms [2] Gymnosperms and flowering plants
[3] Gymnosperms only [4] Bryophytes and pteridophytes

Q.21 Which is pond scum –
[1] *Spirogyra* [2] *Ulothrix* [3] *Anabaena* [4] *Nostoc*

Q.22 Middle sterile part in the moss capsule is –
[1] Columella [2] Foot [3] Spore sac [4] Protonema

Q.23 Gymnosperms are characterised by –
[1] Multiflagellate sperms [2] Naked seeds [3] Winged Seeds [4] Seeds inside fruits

Q.24 Naked seeds occur in –
[1] *Pteris*/Pteridophytes [2] *Cycas*/Gymnosperms
[3] *Funaria*/Bryophytes [4] Maize/Angiosperms

Q.25 First seed plants evolved during –
[1] Cretaceous [2] Carboniferous [3] Devonian [4] Silurian

Q.26 Thermal algae survive at –
[1] Low temperature [2] Hot water of 30°–40°C
[3] Hot spring at 70°C [4] Frozen lakes and ocean

Q.27 An alga rich in proteins is –
[1] *Chlorella* [2] *Oscillatoria* [3] *Ulothrix* [4] *Spirogyra*

Q.28 The alga found in still fresh water is –
[1] *Sargassum* [2] *Laminaria* [3] *Polysiphonia* [4] *Spirogyra*

Q.29 Brown algae have a characteristic pigment of –
[1] Phycocyanin [2] Fucoxanthin [3] Phycocerythrin [4] Haematochrome

Q.30 Walking Fern is named so as –
[1] It knows walking
[2] It is dispersed through walking
[3] Its spores are able to walk
[4] It spreads and propagates vegetatively by its leaf tips

Q.31 Which is incorrect about *Cycas* ?
[1] Its xylem has vessels
[2] It has circinate vernation
[3] It does not have well organised female flower
[4] Its roots possess some blue-green algae

Q.32 Dichotomous branching occurs in –
[1] Liverworts [2] *Funaria* [3] *Dryopteris* [4] *Pinus*

Q.33 Father of Indian Bryology is –
[1] Raj Kumar [2] S.R. Kashyap [3] Maheshwari [4] Khurana

Q.34 Which one has oil and occasionally starch as reserve food ?
[1] Chlorophyceae [2] Phaeophyceae [3] Rhodophyceae [4] Xanthophyceae

Q.35 Indusium occurs in –
[1] *Cycas* [2] *Chlorella* [3] *Pteris* [4] *Riccia*

Q.36 Vegetative reproduction in *Cycas* occurs by –
[1] Scale leaves [2] Sporophylls [3] Bulbils [4] Fragmentation

Q.37 In bryophytes, the posterior part of archegonium grows to protect the embryo. It is –
[1] Paraphysis [2] Calyptra [3] Apophysis [4] Hypophysis

Q.38 Sporophyte of *Riccia* contains –
[1] Spores, elaters and nutritive cells [2] Spores and nutritive cells
[3] Elaters and spores [4] Spores only

Q.39 Multiciliated antherozoids occur in –
[1] *Riccia* and *Funaria* [2] *Pteris* and *Cycas*
[3] *Riccia* and *Pteris* [4] *Marchantia* and *Riccia*

Q.40 Male cone of *Pinus* replaces –
[1] Needles [2] Scales [3] Dwarf shoots [4] Long shoots

Q.41 *Selaginella* multiplies vegetatively through –
[1] Tubers [2] Resting buds [3] Fragmentation [4] All the above

Q.42 Chl a, Chl d and phycoerythrin occur in –
[1] Chlorophyceae [2] Bacillariophyceae [3] Cyanophyceae [4] Rhodophyceae

Q.43 'Nonmotile' gametes occur in –
[1] *Ulothrix* [2] *Spirogyra* [3] *Funaria* [4] *Selaginella*

Q.44 The term bryophyta was coined by –
[1] Iyengar [2] Linnaeus [3] Braun [4] Bentham

Q.45 Kelps are –
[1] Fresh water algae [2] Marine algae [3] Terrestrial plants [4] Amphibious plants

Q.46 Algal zone is characteristic of –
[1] Coralloid root of *Cycas* [2] Normal root of *Cycas*
[3] Normal root of *Pinus* [4] Mycorrhizal root of *Pinus*

Q.47 Storage product of most algae is –
[1] Fat [2] Starch [3] Glycogen [4] Cellulose

Q.48 Ancestors of land plants were –
[1] Red Algae [2] Brown Algae [3] Green Algae [4] Bryophytes

Q.49 Coralloid roots of *Cycas* are –
[1] Negatively geotropic [2] Positively geotropic [3] Positively phototropic [4] Negatively phototropic

Q.50 Simplest stele is –
[1] Atactostele [2] Protostele [3] Dictyostele [4] Stenostele

Q.51 Fern stomata occur on –
[1] Stem [2] Leaf [3] Root [4] Capsule

Q.52 In ferns, the term frond is used for –
[1] Stem [2] Root [3] Leaf [4] Sex organ

Q.53 In fern, archegonia occur on –
[1] Leaves [2] Roots [3] Prothallus [4] Sporophyte

Q.54 Cleavage polyembryony occurs in –
[1] *Pinus* [2] *Cycas* [3] Angiosperms [4] Pteridophytes

Q.55 *Cycas* has two cotyledons but is not included under angiosperms because it has –
[1] Circinate ptyxis [2] Compound leaves [3] Monocot like stem [4] Naked seeds

Q.56 Peat Moss is –
[1] Club Moss [2] Reindeer Moss [3] Irish Moss [4] Bog Moss

Q.57 Rhizoids of *Riccia* are –
[1] Unicellular smooth [2] Unicellular smooth and tuberculate
[3] Multicellular smooth and tuberculate [4] Multicellular tuberculate

Q.58 *Pteridium* possesses –
[1] Polycyclic dictyostele [2] Actinostele
[3] Siphonostele [4] Amphiphloic siphonostele

Q.59 Circinate vernation occurs in –
[1] Algae [2] Moss [3] Fern [4] *Pinus*

Q.60 Lower plants having green pigments similar to those of higher plants are –
[1] Rhodophyceae [2] Chlorophyceae [3] Phaeophyceae [4] Schizomycetes

Q.61 Mosses grow in moist places because they –
[1] Lack vascular tissue
[2] Have gametes which require water for transport
[3] Lack root and stomata [4] Cannot grow on land

Q.62 Chlorenchyma is known to develop from in –
[1] Cytoplasm of *Chlorella* [2] Mycelium of a green mould like *Aspergillus*
[3] Spore capsule of a moss [4] Pollen tube of *Pinus*

Q.63 Which one is living fossil –
[1] *Pinus* [2] *Cycas* [3] *Selaginella* [4] *Metasequoia*

Q.64 Sexual reproduction of *Spirogyra* is an advanced feature as it shows –
[1] Different sizes of motile sex organs [2] Same size of motile sex organs
[3] Morphologically different sex organs [4] Physiologically different sex organs

Q.65 Which amongst the following are not seed producers –
[1] Fern and *Funaria* [2] *Funaria* and *Ficus*
[3] *Ficus* and *Chlamydomonas* [4] *Punica* and *Pinus*

Q.66 Yeast and *Penicillium*/penicillin producing fungus are included under –
[1] Basidiomycetes [2] Zygomycetes [3] Ascomycetes [4] Phycomycetes

Q.67 Common form of food stored in fungal cells is –
[1] Starch [2] Sucrose [3] Glucose [4] Glycogen

Q.68 A fungus which requires only one single host for completion of its life cycle is called –
[1] Heteroecious [2] Autoecious [3] Heterothallism [4] Heterosporous

Q.69 *Penicillium* is commonly known as –
[1] An alga [2] Blue green mould [3] Bacterium [4] Virus

Q.70 Mycorrhiza is –
[1] Symbiotic association of a soil fungus and roots of higher plants
[2] Parasitic association between a fungus and roots of seed plants
[3] Saprophytic association between a fungus and root of seed plants
[4] Symbiotic association between an alga and root of seed plants

Q.71 Mycorrhiza is symbiotic relationship between –
[1] Algae and fungus [2] Algae and bryophytes
[3] Algae and roots of gymnosperms [4] Fungi and roots of higher plants

Q.72 Storage grains produce aflatoxin by growth of –
[1] Virus [2] Yeast [3] Bacterium [4] *Aspergillus flavus*

Q.73 Ergot is obtained from –
[1] *Claviceps purpurea* [2] *Puccinia graminis* [3] *Alternaria solanii* [4] *Fusarium oxysporum*

Q.74 Thread like fungal structutres are –
[1] Hyphae [2] Mycelium [3] Rhizomorphs [4] Sclerotia

Q.75 Study of fungi is –
[1] Palynology [2] Mycology [3] Phycology [4] Microbiology

Q.76 Gills are found in –
[1] *Agaricus* [2] *Puccinia* [3] *Aspergillus* [4] Deuteromycetes

Q.77 Rice crop was destroyed by a fungus which resulted in severe famine of Bengal in 1942–1943. It was due to –
[1] *Penicillium* [2] *Helminthosporium* [3] *Rhizopus* [4] *Puccinia*

Q.78 Alcoholic fermentation is performed by –
[1] *Chlorella* [2] *Agaricus* [3] Yeast [4] *Puccinia*

Q.79 Irish famine is related to a disease of Potato called –
[1] Late blight of Potato [2] Early blight of Potato
[3] Dry rot of Potato [4] Wart of Potato

Q.80 Late blight of Potato is due to –
[1] *Alternaria solani* [2] *Albugo candida*
[3] *Fusarium moniliforme* [4] *Phytophthora infestans*

Q.81 White Rust of Crucifers is due to –
[1] *Albugo candida/Cystopus candidus* [2] *Cercospora personata*
[3] *Colletotrichum falcatum* [4] *Phythium debaryanum*

Q.82 Food is stored in *Rhizopus/Cystopus/*Fungi as –
[1] Protein and steriods [2] Sugar and oil
[3] Protein and starch [4] Glycogen and oil

Q.83 Mycorrhizae are useful for –
[1] Providing resistance against stresses [2] Killing pathogens and insects
[3] Enhanced absorption of mineral nutrients and water from soil
[4] Fixing nitrogen

Q.84 Mushroom is –
[1] *Mucor* [2] *Agaricus* [3] Yeast [4] *Penicillium*

Q.85 *Ustilago* caused plant diseases are called smuts because –
[1] They parasitise cereals [2] Mycelium is black
[3] They develop sooty masses of spores [4] Affected parts become completely black

Q.86 *Claviceps purpurea* is causal organism of –
[1] Smut of Barley [2] Rust of Wheat
[3] Ergot of Rye [4] Powdery Mildew of Pea

Q.87 VAM represents –
[1] Saprophytic fungi [2] Symbiotic fungi [3] Saprophytic bacteria [4] Symbiotic bacteria

Q.88 Smut of Maize is due to –
[1] *Ustilago hordei* [2] *U. nuda* [3] *U. maydis* [4] *U.avenae*

Q.89 Causal organism for Black Stem Rust of Wheat is –
[1] *Melonospora lini* [2] *Claviceps purpurea*
[3] *Sclerospora graminicola* [4] *Puccinia tritici*

Q.90 In *Albugo* the food reserve is mostly –
[1] Glycogen [2] Volutin granules [3] Protein granules [4] Fat

Q.91 Mycelium of *Albugo* is –
[1] Intracellular [2] Intercellular [3] Surface of host [4] Surface of flower

Q.92 Conidia of *Albugo* are arranged –
[1] Irregularly [2] Acropetally [3] Basipetally [4] Intercalary

Q.93 Zoospore of *Albugo* possesses flagella –
[1] Two similar and apical [2] Four similar and median
[3] Four apical [4] Two dissimilar and median

Q.94 Toadstool (poisonous mushroom) is –
[1] *Ganoderma* [2] *Phallus* [3] *Amanita* [4] *Morchella*

Q.95 Yeast is employed for production of –
[1] Curd [2] Cheese [3] Acetic acid [4] Ethyl alcohol

Q.96 Which one is a fungal disease ?
[1] Tuberculosis [2] Cholera [3] Small pox [4] Ringworm

Q.97 Which takes part in symbiosis of lichen ?
[1] Alga-Fungus [2] Alga-Alga
[3] Fungus-Fungus [4] Fungus-Gymnosperms

Q.98 Which statement is wrong about lichens ?
[1] Some species are eaten by Reindeers
[2] Lichens are indicators of pollution
[3] They grow rapidly about 2 cm per day
[4] They have symbiotic relationship between alga and fungus

Q.99 Common Bread Mould is –**]**
[1] Yeast [2] *Rhizopus* [3] *Clostridium* [4] *Myxovirus*

Q.100 Fungal partner of a lichen is commonly –
[1] Ascomycetes [2] Basidiomycetes [3] Phycomycetes [4] Deuteromycetes

Q.101 Yeast is –
[1] Purely aerobic [2] Anaerobic
[3] Rarely anaerobic [4] Both aerobic and anaerobic

Q.102 Algal fungi are placed in –
[1] Ascomycetes [2] Basidiomycetes [3] Phycomycetes [4] Deuteromycetes

Q.103 True symbiotic association between fungus and seed plant is –
[1] Endomycorrhiza [2] Ectomycorrhiza [3] Helotism [4] Commensalism

Q.104 Majority of lichens are made of –
[1] Blue-green algae and basidiomycetes [2] Blue-green algae and ascomycetes
[3] Red algae and ascomycetes [4] Brown algae and higher plants

Q.105 Apple scab is caused by –
[1] *Puccinia* [2] *Erysiphe* [3] *Ustilago* [4] *Venturia*

Q.106 Which one is a laboratory weed ?
[1] *Penicillium* [2] *Aspergillus* [3] *Neurospora* [4] *Yeast*

Q.107 Which is correct about cell wall of bacteria and fungi ? Both have –
[1] Glycopeptide [2] N–acetylglucosamine
[3] N–acetylglucosamine and cellulose [4] Chitin

Q.108 Which one is not correctly matched –
[1] Root Knot Disease–*Meloidogyne javanica* [2] Smut of Bajra–*Tolyposporium penicillariae*
[3] Covered Smut of Barley–*Ustilago nuda* [4] Late Blight of Potato–*Phytophthora infestans*

Q.109 Fungus used in genetic experiments is –
[1] *Rhizopus* [2] *Mucor* [3] *Neurospora* [4] *Claviceps*

Q.110 *Puccinia* infection from Barberry to Wheat occurs through –
[1] Teleutospores [2] Uredospores [3] Aeciospores [4] Pycnospores

Q.111 In Yeast, cell wall contains –
[1] Amylose and glucose [2] Glucose and mannose
[3] Glucose and muramic acid [4] Sucrose and mannose

Q.112 When fungi feed on dead organic matter, they are called –
[1] Parasites [2] Saprophytes [3] Lithophytes [4] Dimorphic

Q.113 Mushroom is –
[1] Saprophyte [2] Facultative parasite [3] Obligate parasite [4] Phagotroph

Q.114 Yeast is important source of –
[1] Proteins [2] Riboflavin [3] Vitamin C [4] Sugars

Q.115 Aflatoxicosis of poultry is due to –
[1] *Candida albicans* [2] *Penicillium notatum* [3] *Aspergillus flavus* [4] *Aspergillus fumigatus*

Q.116 Which one is decomposer –
[1] Lichen [2] *Rhizopus* [3] Algae [4] Carnivores

Q.117 Reindeer Moss is –
[1] Lichen [2] Fungus [3] Bryophyte [4] Cnidarian

Q.118 Fungi Imperfecti is –
[1] Phycomycetes [2] Ascomycetes [3] Basidiomycetes [4] Deuteromycetes

Q.119 Symbiotic association between fungus and root of higher plants is –
[1] Lichen [2] Mycorrhiza [3] Orchid [4] Puffball

Q.120 Fungi are always –
[1] Heterophytes [2] Autotrophic [3] Saprophytic [4] Parasitic

Q.121 Fungal hyphae are able to penetrate the host with the help of –
[1] Mechanical pressure [2] Softening by enzymes
[3] Both 1 and 2 [4] Suckers and hooks

Q.122 "Torula condition" occurs in –
[1] *Rhizopus* [2] *Ulothrix* [3] *Spirogyra* [4] *Riccia*

Q.123 Ergot is got from –
[1] *Neurospora* [2] *Puccinia* [3] *Ustilago* [4] *Claviceps*

Q.124 *Ashbya gossypi* is –
[1] Fungus producing riboflavin [2] Fungus forming B_{12}
[3] Actinomycetes excreting vitamin A [4] Baterium forming antibodies

Q.125 Ainsworth has placed *Rhizopus* in –
[1] Zygomycetes [2] Mastigomycotina [3] Ascomycotina [4] Myxomycotina

Q.126 White rust fungus is –
[1] *Rhizopus* [2] *Albugo* [3] *Pythium* [4] *Ustilago*

Q.127 In *Rhizopus*, hyphae are –
[1] Baranched, septate and uninucleate [2] Branched, aseptate and multinucleate
[3] Unbranched, aseptate and multinucleate [4] Unbranched, septate and coenocytic

Q.128 What is true –
[1] Toadstoll is an edible fungus [2] Rust fungi are homoecious
[3] Parathecium is fruiting body [4] In Mushroom gills produce basidia

Q.129 A fungal disease that spreads by seeds and flowers is –
[1] Loose smut of Wheat [2] Corn smut [3] Covered smut of Barley [4] Soft rot of Potato

Q.130 Toxin is secreted during storage condition by –
[1] *Fusarium* [2] *Colletotrichum* [3] *Penicillium* [4] *Aspergillus*

Q.131 Citric acid is produced by –
[1] *Rhizopus* [2] *Mucor* [3] *Aspergillus* [4] *Saccharomyces*

Q.132 Hyphae of *Aspergillus* are –
[1] Aseptate multinucleate [2] Septate and multinucleate
[3] Aseptate and uninucleate [4] Septate and uninucleate

Q.133 Zygospore is formed in –
[1] *Rhizopus* [2] *Penicillium* [3] *Aspergillus* [4] Yeast

Q.134 Sexual reproduction in *Rhizopus* occurs through –
[1] Gametangial contact [2] Gametangial copulation
[3] Planogametic copulation [4] Spermatogamy

Q.135 An ascomycetous fungus is –
[1] *Agaricus* [2] *Phytopthora* [3] Yeast [4] *Pleurotes*

Q.136 Structure helping lichens in respiration is –
[1] Isidium [2] Soredium [3] Cephalodium [4] Cyphella

Q.137 Basidiospores are produced by –
[1] Yeasts [2] Diatoms [3] *Agaricus* [4] Bacteria

Q.138 Spore dissemination in some liverworts is aided by –
[1] Elaters [2] Indusium [3] Calyptra [4] Peristome teeth

Q.139 Which one of the following is heterosporous ?
[1] *Salvinia* [2] *Adiantum* [3] *Equisetum* [4] *Dryopteris*

Q.140 Select one of the following pairs of important features distinguishing *Gnetum* from *Cycas* and *Pinus* and showing affinities with angiosperms :
[1] Presence of vessel elements and absence of archegonia
[2] Perianth and two integuments
[3] Embryo development and apical meristem
[4] Absence of resin duct and leaf venation

Q.141 In which one of the following, male and female gametophytes do not have free living independent existence ?
[1] *Funaria* [2] *Polytrichum* [3] *Cedrus* [4] *Pteris*

Q.142 Which one of the following is considered important in the development of seed habit ?
[1] Haplontic life cycle [2] Free-living gametophyte
[3] Dependent sporophyte [4] Heterospory

Q.143 Which one of the following is a vascular cryptogam ?
[1] *Marchantia* [2] *Cedrus* [3] *Equisetum* [4] *Ginkgo*

Q.144 Which one of the following plants is monoecious ?
[1] *Cycas* [2] *Papaya* [3] *Marchantia* [4] *Pinus*

Q.145 Which one of the following has haplontic life cycle ?
[1] *Ustilago* [2] Wheat [3] *Funaria* [4] *Polytrichum*

Q.146 Mannitol is the stored food in
[1] *Fucus* [2] *Gracillaria* [3] *Chara* [4] *Porphyra*

147. Ringworm in humans is caused by
(1) bacteria (2) fungi (3) nematodes (4) viruses

148. A sexual reproduction in fungi occurs of
(1) ascospores (2) conidia (3) basiodiospores (4) oospores

149. Which if the following pteridophytes is heterosporous in nature?
(1) *Psilotum* (2) *Adiantum* (3) *Equisetum* (4) *Salvinia*
(5) *Lycopodium*

150. Fern gametophyte shows
(1) homothallic (2) fragmentation (3) heterothallic (4) None of these

151. Which is the source of turpentine oil ?
(1) Gymnospermic wood (2) Angiospermic wood
(3) Gymnospermic seed (4) Angiospermic seed

152. In *Cycas,* pollination occurs at ..... celled stage.
(1) One (2) two (3) three (4) four

153. Gymnosperms lack fruits, why?
(1) Seeds absent (2) Ovule absent (3) Ovary absent (4) Ovary fused

ANSWERY KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ans	1	2	4	2	4	2	2	4	2	4	1	3	1	1	2	3	3
Que.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Ans	2	1	4	1	1	2	2	3	3	1	4	2	4	1	1	2	4
Que.	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Ans	3	3	2	2	2	3	4	4	2	3	2	1	2	3	1	2	2
Que.	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
Ans	3	3	1	4	4	2	1	3	2	2	3	2	4	1	3	4	2
Que.	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
Ans	2	1	4	4	1	1	2	1	2	3	1	4	1	4	3	2	4
Que.	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ans	3	2	3	4	1	2	3	4	3	4	4	1	3	2	1	4	3
Que.	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
Ans	2	2	4	2	2	3	3	3	2	2	1	2	3	2	1	4	2
Que.	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136
Ans	1	3	1	4	1	1	2	2	4	1	4	3	2	1	2	3	4
Que.	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
Ans	3	1	1	1	3	4	3	4	1	1	2	2	4	1	1	3	3

MYCOPLASMA, BACTERIA & VIRUS (EXERCISE-2)

Q.1 Mycoplasmas differ from viruses in that they are sensitive to –
[1] Penicillin [2] Tetracyclines [3] Sugars [4] Amino acids

Q.2 In bacteria the respiratory enzymes are located on –
[1] Plasmid [2] Episome [3] Mesosome [4] Nucleoid

Q.3 *Staphylococcus* has –
[1] Cubical colony [2] Bunch–like irregular colony
[3] Chain like colony [4] Plate like colony

Q.4 The folds of plasma membrane in bacterial cells are known as –
[1] Episomes [2] Mesosomes [3] Sphaerosomes [4] Acrosomes

Q.5 T.B. is produced by –
[1] *Mycobacterium* species [2] *Aspergillus* species
[3] *Clostridium* species [4] *Vibrio* species

Q.6 *Nitrosomonas* changes –
[1] Nitrite to nitrate [2] Nitrogen to ammonia [3] Ammonia to nitrogen [4] Ammonia to nitrite

Q.7 In photosynthetic bacteria, the pigments occur in –
[1] Chloroplasts [2] Chromatoplasts [3] Chromatophores [4] Leucoplasts

Q.8 Sterilisation by autoclaving is carried out to –
[1] Kill bacteria and other pathogens [2] Kill viruses
[3] Kill bacteria and enzymes [4] Inactivate enzymes

Q.9 The main function of elementary bodies in some primitive bacteria is –
[1] Reproduction [2] Respiration [3] Secretion [4] Food storage

Q.10 *Yersinia pestis* causes –
[1] Syphilis [2] Leprosy [3] Whooping cough [4] Plague

Q.11 Which one is found in alimentary canal of humans –
[1] *Pseudomonas* [2] *Rhizobium* [3] *Bacillus* [4] *Escherichia coli*

Q.12 Sex factor of bacteria is –
[1] RNA [2] Sex pili [3] F–factor [4] Chromosome replicon

Q.13 Hereditary material of *Escherichia coli* is –
[1] Single stranded DNA [2] Double stranded DNA
[3] Single stranded RNA [4] Double stranded RNA

Q.14 Bacterial plasmids are –
[1] Circular *ds*RNA [2] Circular *ds*DNA [3] Linear *ds*DNA [4] Linear *ds*RNA

Q.15 Diphtheria is due to –
[1] Poison released by living bacteria [2] Poison released by dead bacteria
[3] Poison released by virus [4] Excessive immune response

Q.16 Two bacteria commonly employed in genetic engineering are –

[1] *Rhizobium* and *Diplococcus* [2] *Escherichia* and *Agrobacterium*

[3] *Nitrobacter* and *Azotobacter* [4] *Nitrosomonas* and *Klebsiella*

Q.17 Transfer of genetic information through transduction involves –

[1] Conjugation

[2] Bacteriophage released from donor cell

[3] Another bacterium

[4] Physical contact between donor and recipient strains

Q.18 DNA of *Escherichia coli* is –

[1] *ss* and circular [2] *ss* and linear [3] *ds* and linear [4] *ds* and circular

Q.19 Botulism caused by *Clostridium botulinum* affects –

[1] Spleen [2] Intestine

[3] Neuromuscular junctions [4] Lymph glands

Q.20 NAM of bacterial cell wall is –

[1] Protein [2] Fat [3] Organic acid [4] Amino Sugar

Q.21 *Agrobacterium tumefaciens* causes –

[1] Wilt [2] Damping off [3] Rust [4] Crown gall

Q.22 A bacterium which has been genetically modified to control pollution is –

[1] *Pseudomonas* [2] *Rhizobium* [3] *Nitrobacter* [4] *Nitrosomonas*

Q.23 A bacterium having flagella on the opposite ends is –

[1] Monotrichous [2] Lophotrichous [3] Amphitrichous [4] Polytrichous

Q.24 During conjugation, bacteria attach by means of –

[1] Flagella [2] Pili [3] Cilia [4] Hair

Q.25 Witches Broom of Potato is caused by –

[1] Mycoplasma [2] Bacteria [3] Viruses [4] All of the above

Q.26 Which one does not evolve oxygen –

[1] Photosynthetic bacteria [2] Blue Green algae

[3] Green algae [4] Autotrophic plants

Q.27 Peritrichous bacteria have flagella –

[1] All over the body [2] At one end [3] All both ends [4] None

Q.28 Comma shaped bacteria are –

[1] Bacilli [2] Spirilla [3] Vibrios [4] Cocci

Q.29 In bacteria, plasmid is –

[1] Extra chromosomal material [2] Main DNA

[3] Non functional DNA [4] Repetative gene

Q.30 Chromosomes in a bacterial cell can be 1–3 in number and –

[1] Are always circular

[2] Are always linear

[3] Can be either circular or linear but never both within the same cell

[4] Can be circular as well as linear within the same cell

Q.31 Not applicable to viruses is –

[1] Cannot use O_2 for respiration [2] Made of proteins and nucleic acids

[3] Can be grown in sugary medium [4] Multiply only in living host cells

Q.32 Reverse transcriptase is –

[1] RNA dependent RNA polymerase [2] DNA dependent RNA polymerase

[3] DNA dependent DNA polymerase [4] RNA dependent DNA polymerase

Q.33 Tobacco Mosaic Virus (TMV) genes are –

[1] Double stranded RNA [2] Single stranded RNA

[3] Polyribonucleotides [4] Proteinaceous

Q.34 Which of the following cannot be grown on artificial culture medium –

[1] *Escherichia coli* [2] TMV [3] *Aspergillus* [4] Yeast

Q.35 In some viruses, RNA is present instead of DNA indicating that –

[1] Their nucleic acid must combine with host DNA before replication

[2] They cannot replicate

[3] There is no hereditary information [4] RNA can act to transfer heredity

Q.36 Tailed bacteriophage is –

[1] Nonmotile [2] Actively motile in water

[3] Motile on bacterial surface [4] Motile on surface of plant leaves

Q.37 Genetic material of influenza virus is –

[1] Single helix DNA [2] Double helix DNA [3] Double strand RNA [4] Single strand RNA

Q.38 Protein cover of virus is –

[1] Capsid [2] Virion [3] Viroid [4] Bacterial wall

Q.39 Which of the following is an example of viral disease –

[1] Leaf curl of Papaya [2] Late blight of Potato

[3] Black rust of Wheat [4] Red rot of Sugarcane

Q.40 TMV has a size of –

[1] 50 nm x 10 nm [2] 100 nm x 20 nm [3] 300 nm x 18 nm [4] 500 nm x 24 nm

Q.41 Polio Virus has –

[1] ss DNA [2] ds DNA [3] ss RNA [4] ds RNA

Q.42 Viral capsid is made of –

[1] Carbohydrates [2] Lipid [3] Protein [4] All of the above

Q.43 Temin worked on virus –

[1] Rhinovirus [2] Dengue virus [3] Herpes virus [4] Retrovirus

Q.44 Viruses cannot multiply of their own because they –

[1] Do not have sex organs

[2] Lack genetic material

[3] Lack cellular machinery to use its genetic material

[4] None of the above

Q.45 Viruses are living because –

[1] They can reproduce [2] They have protein synthesising machinery

[3] They have some genes [4] They are parasites

Q.46 Caulimo (Cauliflower Mosaic) viruses have –

[1] Double stranded DNA [2] Single stranded DNA

[3] Single stranded RNA [4] Double stranded RNA

Q.47 Which one is a bacteriophage –

[1] Vibrio bacterium [2] Bacterium infecting virus

[3] Virus infecting bacterium [4] Cyanobacterium

Q.48 Viruses are no more "alive" than isolated chromosomes because –

[1] They require both RNA and DNA [2] They both need food molecules

[3] They both require oxygen for respiration [4] Both require the environment of a cell to replicate

Q.49 Which one of the following statements about viruses is correct –

[1] Viruses possess their own metabolic system [2] All viruses contain both RNA and DNA

[3] Viruses are obligate parasites [4] Nucleic acid of viruses is known as capsid

Q.50 Viroids have –

[1] Single stranded RNA not enclosed by protein coat

[2] Single stranded DNA not enclosed by protein coat

[3] Double stranded DNA enclosed by protein coat

[4] Double stranded RNA enclosed by protein coat

Q.51 Which one of the following is a viral disease of poultry ?

[1] Salmonellosis [2] Coryza [3] New Castle disease [4] Pasteurellosis

Q.52 A genetically engineered micro-organism used successfully in bioremediation of oil spills is a species of

[1] Pseudomonas [2] Trichoderma [3] Xanthomonas [4] Bacillus

Q.53 Which one of the following statements about mycoplasma is wrong ?

[1] They are also called PPLO [2] They are pleomorphic

[3] They are sensitive to penicillin [4] They cause diseases in plants

Q.54 Bacterial leaf blight of rice is caused by a species of :

[1] *Pseudomonas* [2] *Alternaria* [3] *Erwinia* [4] *Xanthomonas*

Q.55 *Thermococcus, Methanococcus, Methanobacterium* exemplify :

[1] Archaebacteria that lack any histones resembling those found in eukaryotes but whose DNA is negatively supercoiled

[2] Bacteria whose DNA is relaxed or positively supercoiled but which have a cytoskeleton as well as mitochondria

[3] Bacteria that contain a cytoskeleton and ribosomes

[4] Archaebacteria that contain protein homologous to eukaryotic core histones

Q.56 Which one of the following is linked to the discovery of Bordeaux mixture as a popular fungicide ?

[1] Downy mildew of grapes [2] Loose smut of wheat

[3] Black rust of wheat [4] Bacterial leaf blight of rice

Q.57 T.O.Diener discovered a

[1] Infectious protein [2] Bacteriophage

[3] Free infectious RNA [4] Free infectious DNA

Q.58 In microbial genetics, which one is referred to as Griffth effect?

[1] Conjugation [2] Transduction [3] Transformation [4] Sexduction

Q.59 The kingdom of prokaryotes is

[1] Protista [2] Monera [3] Fungi [4] Plantae

Q.60 Membrane-bound organelles are absent in

[1] *Saccharomyces* [2] *Streptococcus* [3] *Chlamydomonas* [4] *Plasmodium*

Q.61 One of the free-living, anaerobic nitrogen-fixer is

[1] *Beijernickia* [2] *Rhodospirillum* [3] *Rhizobium* [4] *Azotobacter*

Q.62 The common nitrogen-fixer in paddy fields is

[1] *Rhizobium* [2] *Azospirillum* [3] *Oscillatoria* [4] *Frankia*

Q.63 Specialized cells called heterocysts are present in

[1] Dinoflagellates [2] Chrysophytes [3] Euglenoids [4] Cyanobacteria

(5) Archaebacteria

Q.64 Which of the following bacteria fixes nitrogen without any plant association?

[1] *Rhizobium* [2] *Nostoc* [3] *Anabaena* [4] *Azotobacter*

Q.65 Which of the following is a bacterial disease?

[1] Rust of wheat [2] Potato leaf roll [3] sugarcane mosaic [4] Brown rot of potato

Q.66 Bacteria that fix CO_2 by using chemical energy as source, are

[1] photoautotrophs [2] photoheterotrophs [3] chemoautotrophs [4] chemoheterotrophs

ANSWERY KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	2	3	2	2	1	4	3	1	1	4	4	3	2	2	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans	2	2	4	3	4	4	1	3	2	1	1	1	3	1	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans	3	4	3	2	4	1	4	1	1	3	3	3	4	3	1
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans	1	3	4	3	1	3	1	3	4	4	1	3	3	2	2
Que.	61	62	63	64	65	66									
Ans	2	2	4	4	4	3									

02 Life Cycle of Lower Plants

ULOTHRIX

1. Classification/Systemic Position :

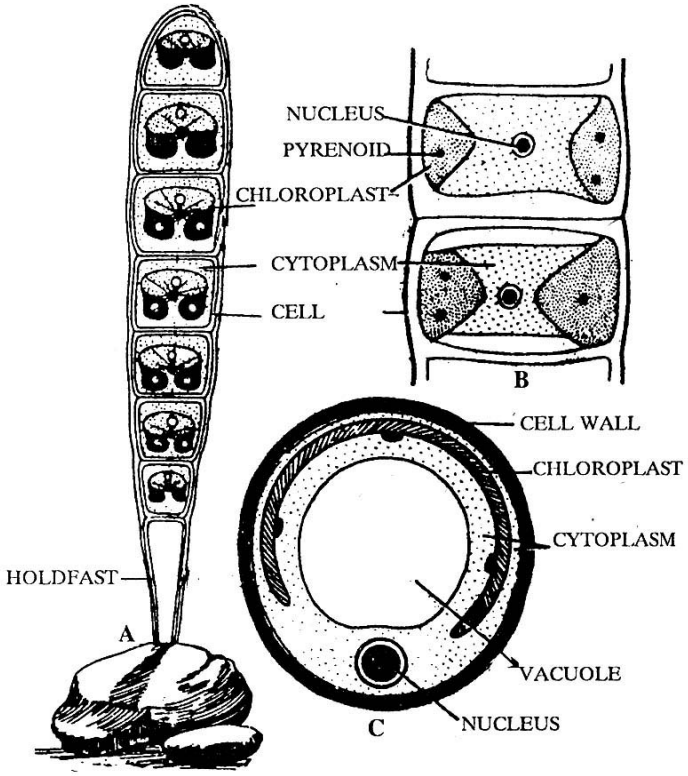
Class	:	Chlorophyceae
Order	:	Ulotrichales
Family	:	Ulotrichaceae
Genus	:	*Ulothrix*

2. Occurrence :

Ulothrix occurs in fresh flowing waters. The plants are filamentous and unbranched which remain attached to the substratum. *U. zonata* is found in cold streams. *U. implexa* grows on rocks or stones. *U. flacca* is found in sea waters.

3. Structure :

The thallus is unbranched, uniseriate filament. It is attached to the substratum by means of a basal cell called holdfast.



***Ulothrix* filament, B–C, Cell structure.**

The holdfast lacks a chloroplast. The adult filaments usually become free–floating. The cells are short, cylindrical, quadrate, or squarish. Every cell (except basal holdfast) is capable of division. The cells are uninucleate. Each cell has a single girdle shaped chloroplast. The chloroplast has one or more pyrenoids . The apical cell of the filament is dome–shaped. The cell wall is rigid and consists of two layers. The inner layer is made up of cellulose and the outer layer of pectic substances.

4. Reproduction :

Reproduction is vegetative, asexual and sexual.

(A) Vegetative reproduction – It takes place by fragmentation. A filament breaks into two or more pieces, each of which grows into a new plant.

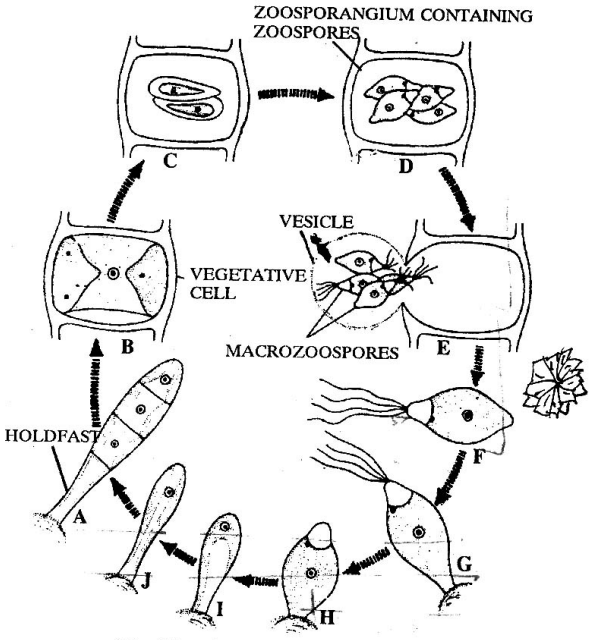
(B) Asexual reproduction – Asexual reproduction may take place by any of the following methods:
(a) Zoospores (b) Aplanospores (c) Hypnospores (d) Akinetes (e) Palmella stage

(a) By zoospores – Any vegetative cell except the holdfast can form 8, or rarely 16, zoospores under favourable conditions. Depending on the number of divisions, the mother cell may produce following type of zoospores.

(i) Quadriflagellate macrozoospores – They are of usually large size. Each cell produces usually 4, sometimes 8, macrozoospores bearing four anterior flagella.

(ii) Quadriflagellate microzoospores – They resemble the quadriflagellate macrozoospores in all respects, except in having a smaller size. Usually 8 such quadriflagellate microzoospores are produced per cell.

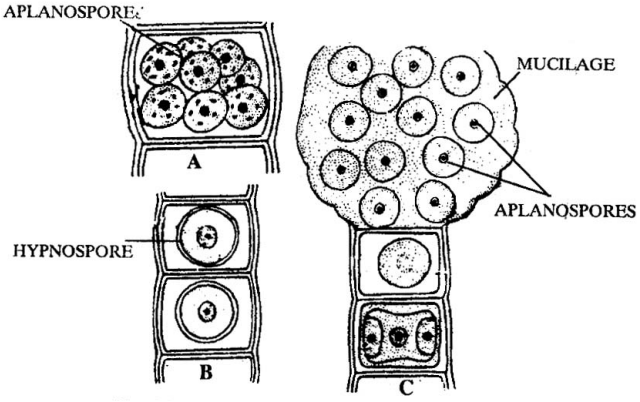
(iii) Biflagellate microzoospores – They are small in size, having two anterior flagella. A cell can produce 8 – 16 microzoospores.



Asexual reproduction by quadriflagellate macrozoospores.

(b) By aplanospores – Under unfavourable conditions, the protoplast of a zoosporangium, instead of forming zoospores, develops into thin–walled, non–motile aplanospores.

(c) By hypnospores – Sometimes the protoplast of a cell may round up to form a single large thick–walled hypnospore. Hypnospores are meant for passing over adverse periods.

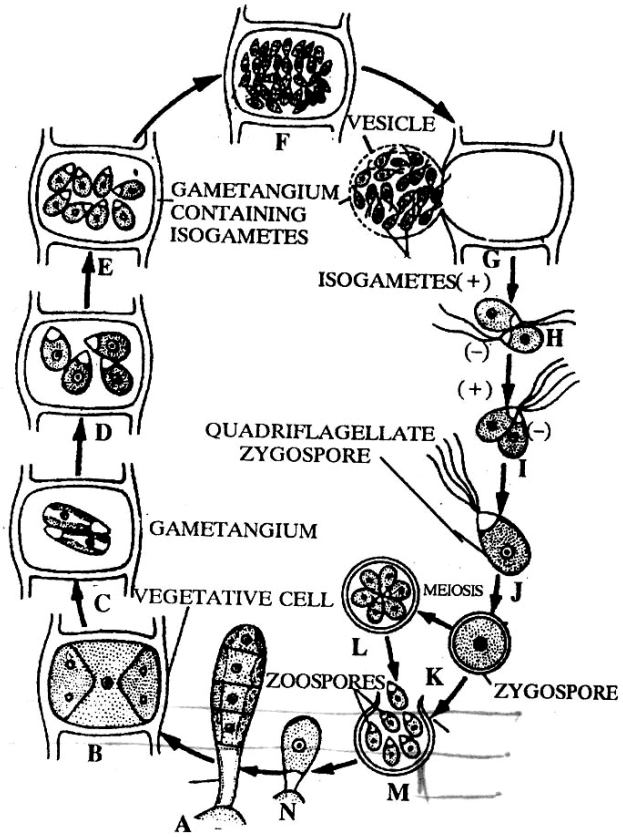


A–Aplanospores, B–Hypnospores, C–Palmella stage.

(d) By akinetes – Occasionally cells of some species of *Ulothrix* store food material and their cell walls thicken. These cells are called akinetes which are resting structures. In the formation of akinete the wall of the cell becomes the wall of the spore.

(e) By palmella stage – Sometimes under unfavourable conditions the protoplast of a cell divides to form many daughter protoplasts. These remain embedded in a mucilaginous matrix formed due to gelatinization of the cell wall.

(C) Sexual reproduction – Sexual reproduction in *Ulothrix* is isogamous, that is, the motile gametes formed are of similar shape and size.



Sexual reproduction

5. Alternation of generations :

Ulothrix plant is haploid (containing'n' number of chromosomes). The only diploid stage (2n) in the life cycle is the zygospore. The zygospore undergoes meiosis and again forms haploid spores (aplanospores or zoospores). Thus, there is an alternation of a haploid generation with a diploid generation. This type of life cycle is considered very simple.

ALBUGO

1. Classification/Systemic Position :

Class	:	Phycomycetes
Order	:	Perinosporales
Family	:	Albuginaceae
Genus	:	*Albugo*

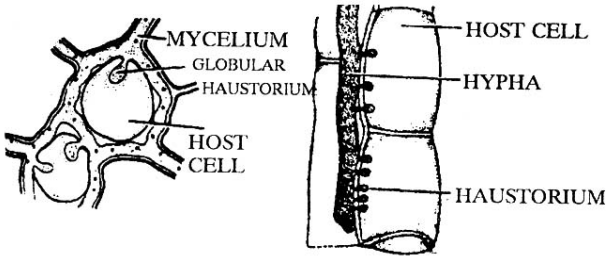
2. Occurrence :

Albugo is an obligate parasite. It is parasitic mainly on the members of families Cruciferae and Compositae. The disease caused by this fungus is known as white rust. The fungus forms shiny white patches on the leaves, mostly on their lower surfaces, stems and petioles. The fungus also causes hypertrophy.

The most common and well–known species is *Albugo candida* which attacks mainly the plants of family Cruciferae e.g. radish, mustard, cabbage, cauliflower, etc.

3. Structure :

The mycelium is intercellular, composed of branched, aseptate (coenocytic) hyphae. The mycelium forms globular haustoria in the nearby host cells for absorbing nutrition. The cell wall is made up of chitin and cellulose.

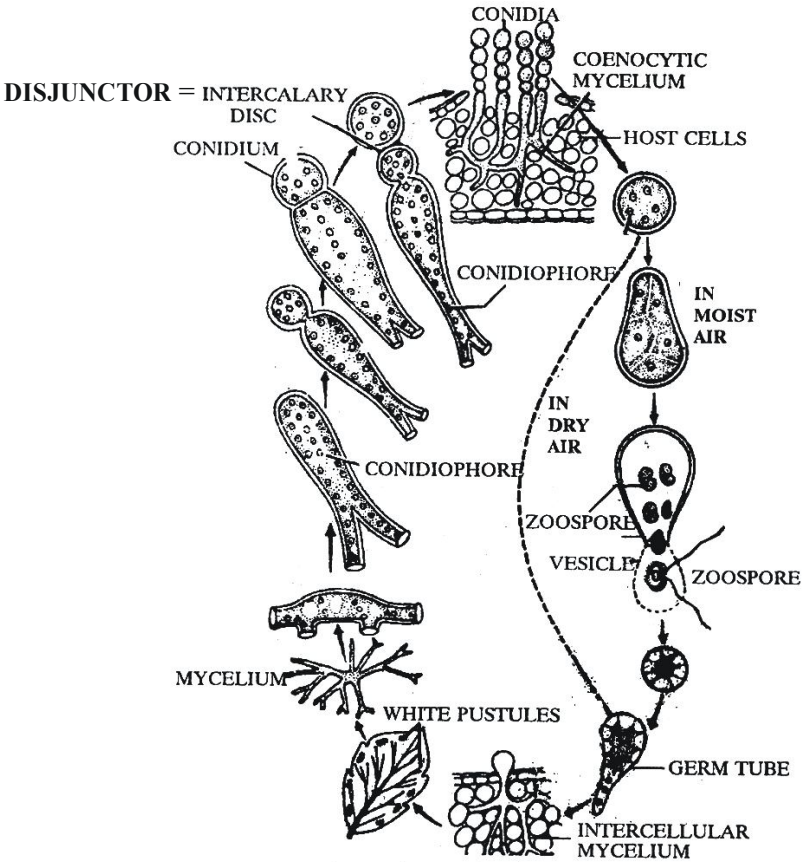


A part of intercellular mycelium showing haustoria in host cells.

4. Reproduction :

Reproduction occurs by asexual and sexual methods.

(i) Asexual reproduction – Asexual reproduction takes place by the formation of sporangia or conidia. The conidia remain attached in the form of chains. The walls between the conidia fuse to form a gelatinous disc-like structure called disjunctor. The conidia are disseminated by wind. Germination of conidia occurs when they reach a suitable host. The mode of germination depends on the availability of water or even moist air.

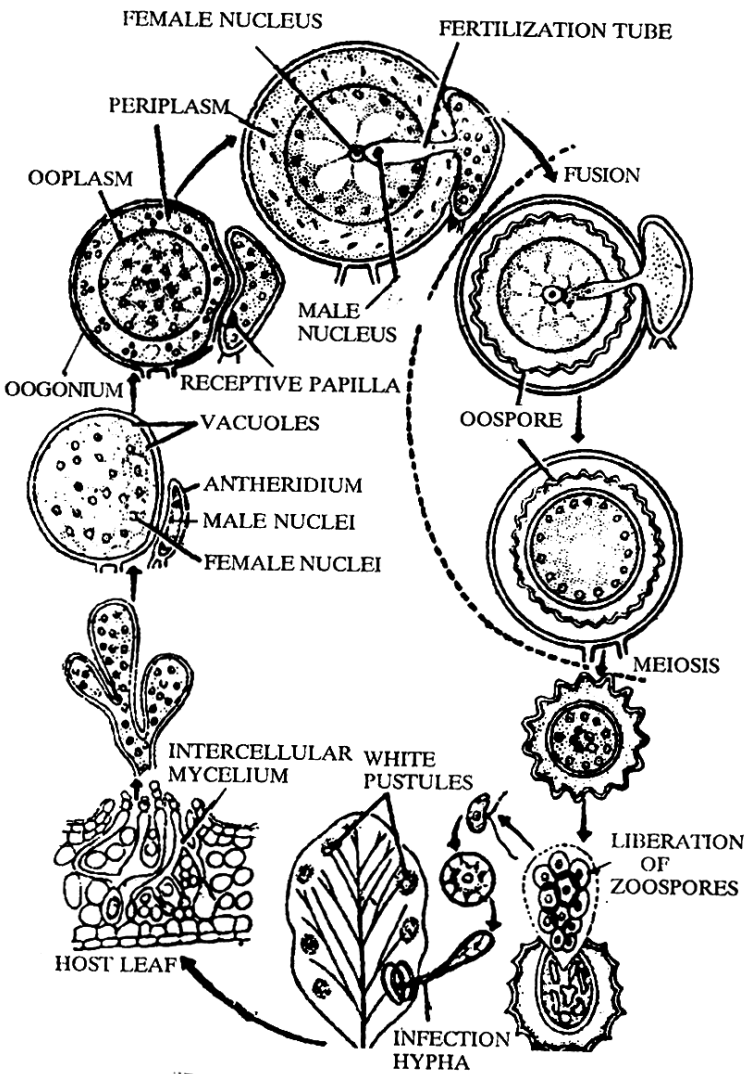


Asexual reproduction in *Albugo.*

(a) If water is available, biflagellate and reniform zoospores (4–12 in number) are formed in the conidium (sporangium).

(b) If water is not available, the conidia germinate directly by forming germ tubes.

(ii) Sexual reproduction – It is of oogamous type and takes place with the help of antheridia and oogonia. The antheridia are club–shaped and the oogonia are globular. At the time of fertilization a receptive papilla develops on one side of the oogonium through which the fertilization tube enters into the oogonium. Inside the oogonium the male nucleus fuses with the egg nucleus. The diploid zygote develops a warty wall and becomes the oospore. After a period of rest, the oospore germinates and produces reniform, biflagellate zoospores. Most part of the life cycle of *Albugo* is gametophytic. The sporophytic phase is limited only to the oospore stage.



Sexual reproduction In *A. candida.*

According to Sansome and Sansome (1974), meiosis in *A. candida* occurs inside the antheridia and oogonia, and not at the time of germination of oospore. Thus, they consider *A. Candida* as a diploid plant.

RICCIA

1. Classification/Systemic Position :

Class : Hepaticopsida (Hepaticae)

Order : Marchantiales

Family : Ricciaceae

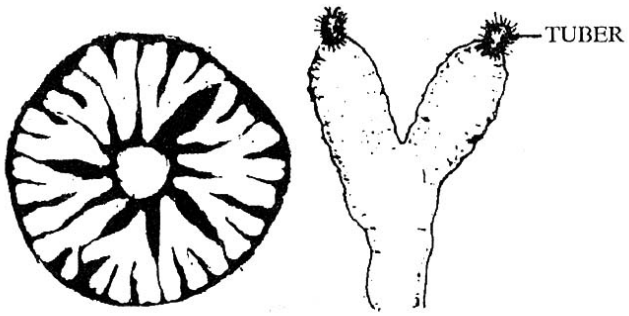
Genus : *Riccia*

2. Occurrence :

The plants occur on moist soil or rocks. Terrestrial species grow on damp soil forming rosettes. *R.fluitans* is an aquatic species. *R. himalayensis* (*R. discolor*) is a common terrestrial species.

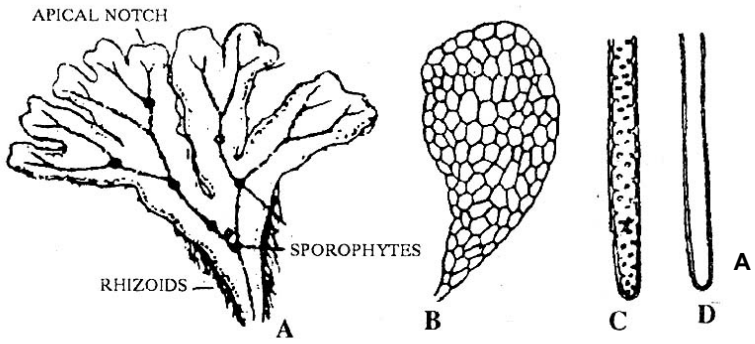
3. Gametophytic phase :

(i) External structure – The plant body is a thallus and a gametophyte. It is small, green, flat and fleshy. The thallus is dorsiventral and dichotomously branched. *Riccia* plants grow so closely that a rosette is formed.



A–A patch of *Riccia* plants, B–A single plant.

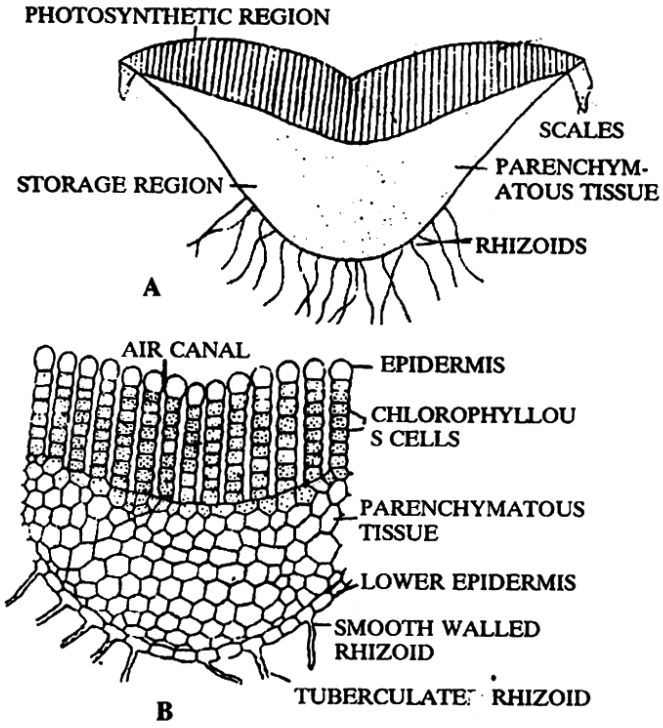
The dorsal surface of the thallus is smooth but the ventral surface has rhizoids and scales. Scales are found on the margins, while rhizoids are present in the mid–rib region of thallus. Rhizoids are unicellular and unbranched and are of two types – smooth and tuberculate. Scales are minute, multicellular structures which protect the growing point.



A–Dorsal view of thallus, B–Scale, C–Tuberculate rhizoid, D–*Smooth rhizoid*.

(ii) Internal structure – The thallus is internally differentiated into

(a) an upper or dorsal photosynthetic region, and (b) a lower or ventral storage region.



A–Outline diagram of V.S. of *Riccia* thallus, B–Cellular dlagram of the same.

(a) Photosynthetic region – It consists of vertical rows of chlorenchymatous cells. In between these vertical rows are present very narrow air canals or air chambers. The uppermost cell of each row is enlarged and non–green.

(b) Storage region – The lower portion consists of closely–packed parenchymatous cells without intercellular spaces. The cells do not contain chloroplasts. They store water and food. The lowermost row of cells form the lower epidermis. Rhizoids and scales develop from the lower epidermis.

4. Reproduction :

Only vegetative and sexual methods of reproduction are found in *Riccia*.

(i) Vegetative reproduction – *Riccia* multiplies vegetatively by the following methods :

(a) Fragmentation – When death and decay of older portions of the thallus reaches dichotomy, the young lobes become separated. Each lobe grows into a new thallus by apical growth.

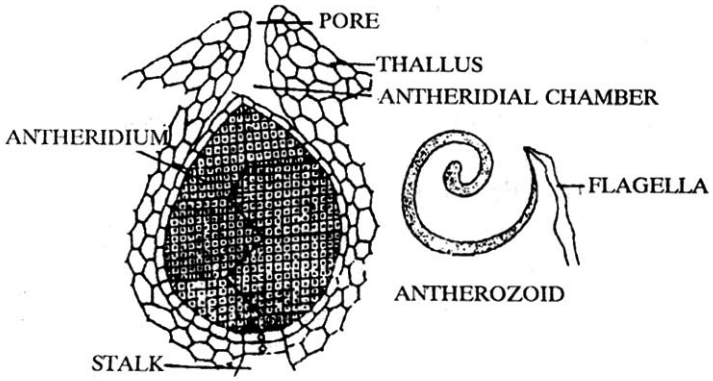
(b) Advetitious branches – In *R. fluitans* adventitious branches develop from the ventral surface. These are detached from the thallus and develop into new plants.

(c) Persistent apices – In many species of *Riccia* the complete plant except the growing apex of the thallus lobe is killed during the dry season.

(d) Tubers – In *R. discolor* the apices of the thallus lobes become thickened and form tubers.

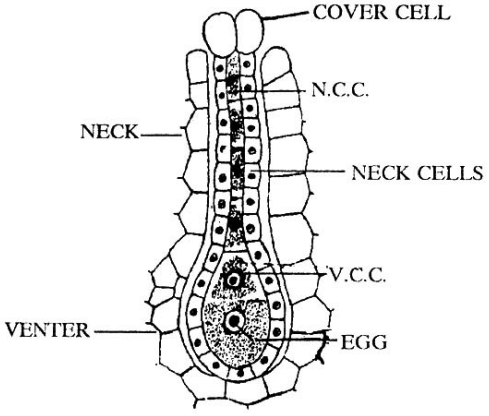
(ii) Sexual reproduction – Sex organs lie embedded in the thallus in the dorsal furrow. The male sex organ is called antheridium, and the female archegonium.

Antheridium – It consists of a small stalk and an oval body. It is situated in a deep pit, called **antheridial chamber**. The antheridium is surrounded by an outer jacket of sterile cells.



Antheridium and antherozoid of *Riccia*.

Archegonium – Archegonium is a flask–shaped structure. It consists of two parts–the basal swollen venter and the long narrow neck. The archegonium is surrounded by a layer of sterile cells forming a protective jacket. The neck consists of a vertical row of four cells, the neck canal cells. The venter has two cells, the lower large egg cell and the upper small venter canal cell.



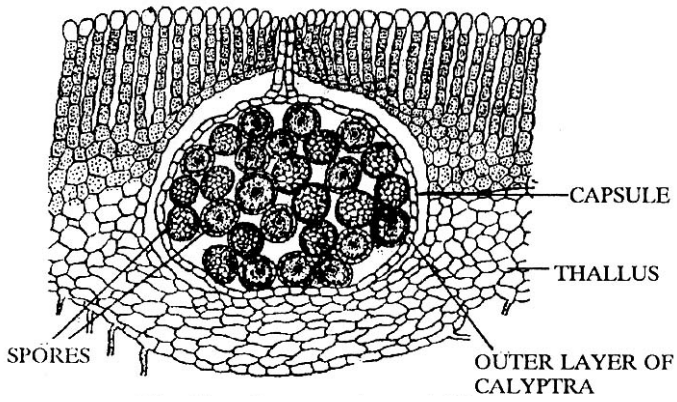
Mature archegonium of *Riccia*.

Fertilization – Moisture is essential for fertilization. The antherozoids swim to the archegonia in a thin film of water in the dorsal furrow. They enter the open neck where only one antherozoid fuses with the egg. The gametophytic phase ends with fertilization.

5. Sporophytic phase :

Zygote – Zygote is formed as a result of fertilization.

Embryo – The zygote undergoes many divisions and forms a spherical mass of undifferentiated cells called embryo. The sporogonium of *Riccia* is very simple. It has no foot or seta. It has only a spore–sac or capsule.



Sporogonium of *Riccia.*

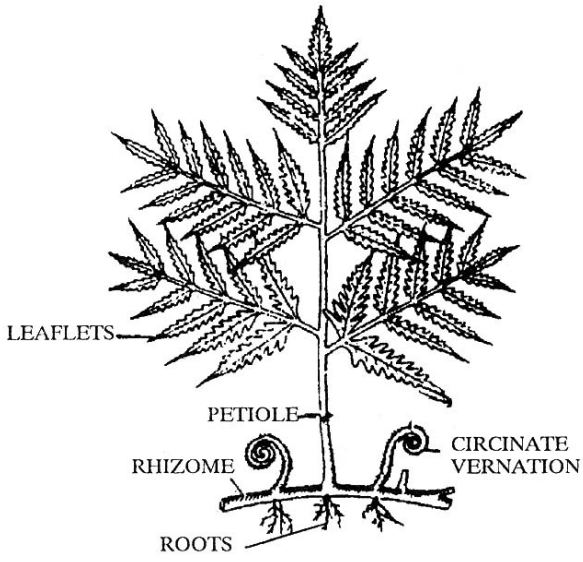
6. Alternation of generations

In the life cycle of *Riccia* there occur two distinct phases. They are the independent green gametophyte and the dependent colourless sporophyte. These two individuals occur one after the other. This phenomenon is called the alternation of generations. It is a constant feature of all bryophytes including *Riccia*. These two alternating generations are morphologically different. Therefore, this type of alternation of generation is called heteromorphic. The life cycle is haplodiplobiontic.

PTERIDIUM

1. Classification/Systemic position :

Class : Leptosporangiopsida
Order : Filicales
Family : Polypodiaceae
Genus : *Pteridium*



A *Pteridium* plant.

2. Occurrence :

Plants are found growing both in hills and plains in moist and shady places. The plant grows vigorously and assumes a gregarious habit.

3. The plant body (sporophyte) :

The plant body is differentiated into roots, stem and leaves.

(i) External structure

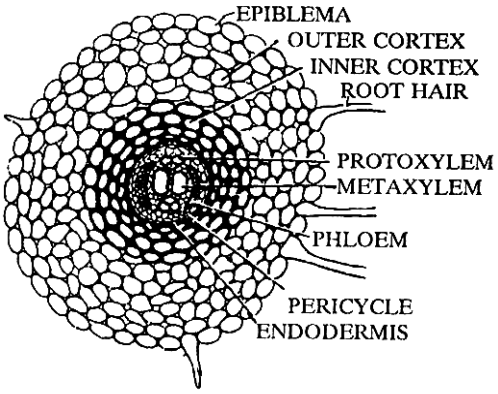
(a) Roots – The rhizome produces adventitious roots.

(b) Stem – The stem is in the form of an underground rhizome.

(c) Leaves – Leaves (fronds) are large and much divided. Young leaves are circinately coiled. The leaf lamina is pinnately compound consisting of leaflets (pinnae). The young leaves and young rhizome remain covered by multicelled dry scales, called ramenta.

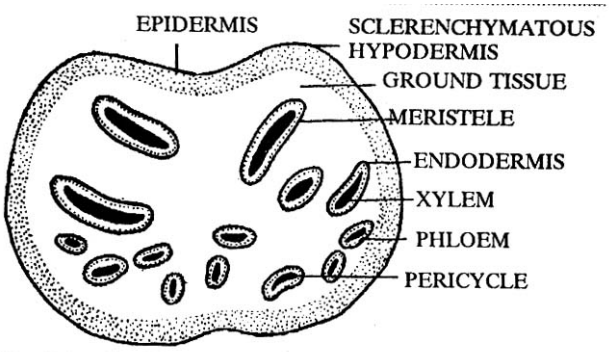
(ii) Internal structure

(a) Root – The outermost single layer is epiblema from which root hairs arise. The cortex surrounds endodermis and pericycle. The stele is diarch. Phloem is present on both sides of the xylem.



T.S. of the root of *Pteridium.*

(b) Petiole – A transverse section shows a single–layered epidermis, followed by hypodermis made up of thick–walled sclerenchyma cells. Below the hypodermis is the parenchymatous ground tissue with many vascular strands or meristeles. The stele is a dictyostele.

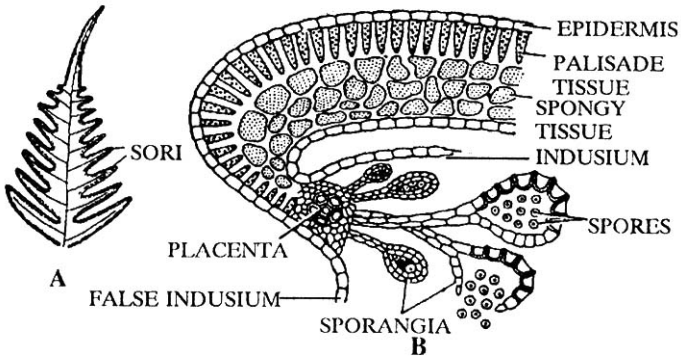


Outline sketch of the T.S. of petiole.

4. Reproduction :

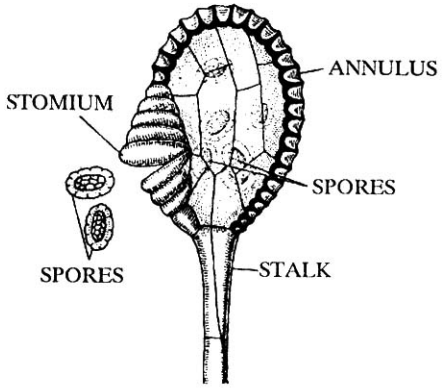
(i) Vegetative reproduction – It is very common and occurs by death and decay of the older parts of the rhizome.

(ii) Asexual reproduction – *Pteridium* plant is a sporophyte. It bears sporangia and spores. The spores are of one kind only (homosporous). The sporangia–bearing leaves are called sporophylls. Linear type of sorus is called coenosorus. Each sporangium develops from a single cell, that is, the development is of leptosporangiate type.



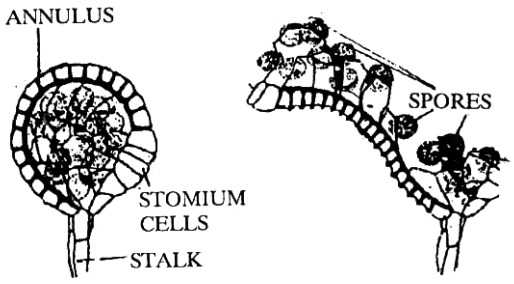
A–Coenosorus of *Pteridium* B–V.S. of the sporophy showing sporangia and spores.

(a) Structure of sporangium – Each sporangium has a stalk and a capsule. The stalk is long, narrow and multicellular, made up of three vertical rows of cells. The capsule is oval. The three–fourth part of the capsule forms the annulus and the remaining part forms the stomium. The capsule ruptures at the stomium. The capsule has 8 or 16 spore mother cells. Each spore mother cell undergoes reduction division, forming 4 haploid spores. Thus 32 or 64 spores are formed in each sporangium.



Structure of a sporangium.

(b) Dehiscence of sporangium – When the sporangium is mature, the annulus becomes highly hygroscopic. In dry air the water evaporates from the thin outer and side walls of annulus with the result that the outer thin walls contract. Thus it exerts a pressure on the wall resulting in breaking of the capsule between the cells of stomium thereby releasing the spores.

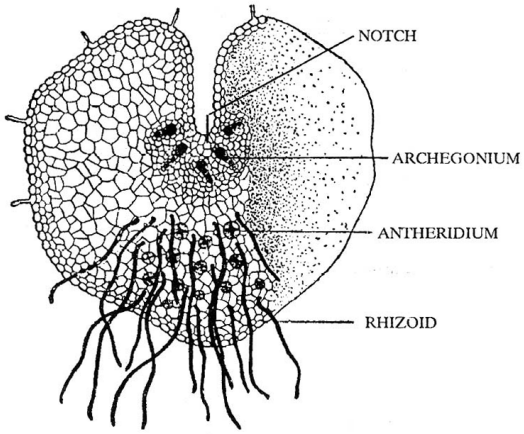


Sporangium before and after dehiscence.

5. The gametophyte :

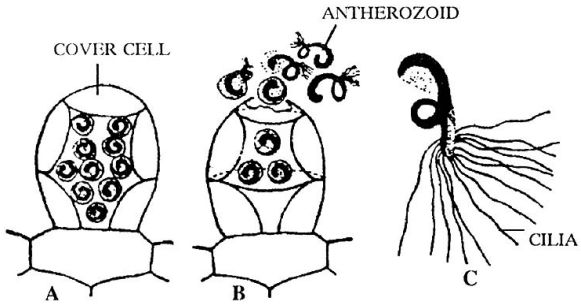
(a) Spore – It is the first cell of gametophytic phase. the spore germinates to form a filamentous gametophyte which develops into a prothallus.

(b) Prothallus – It is a heart–shaped and green structure. It lies flat on the soil surface, attached by means of numerous delicate rhizoids. Both antheridia and archegonia are found on the same prothallus (monoecious). Sex organs are present on the ventral surface of the prothallus. Antheridia are present in between the rhizoids while archegonia are present near the apical notch.



Ventral view of prothallus.

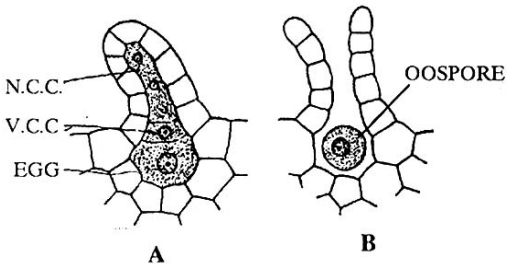
(c) Antheridium – Each antheridium consists of a three celled jacket which surrounds a cavity. The two lower jacket cells are ring–like and the upper cell is called the cover cell. The cavity contains spirally–coiled multiflagellate antherozoid. Dehiscence of antheridium takes place in presence of water.



A–Structure of an antheridium, B–Liberation of antherozoids from antheridium, C–An antherozoid.

(d) Archegonium – The archegonium is a flask–shaped body, consisting of a swollen venter and a curved protruding neck. The venter contains a large egg and a small venter canal cell.

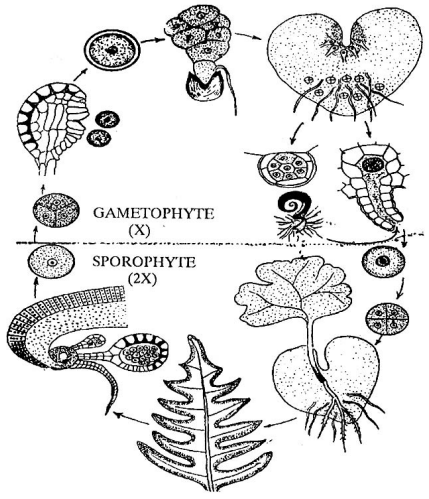
(e) Fertilization – Many antherozoids may enter into an archegonium but only one fuses with the egg forming a zygote.



Archegonia of *Pteridium.*

6. Embryo and young sporophyte :

As a result of fertilization the zygote is formed. The young sporophyte is first dependent on the prothallus for food and water, but soon becomes independent. The prothallus dries up and the young sporophyte develops into an adult plant.



Diagrammatic representation of the life cycle of *Pteridium.*

CYCAS

System Position :

Kingdom	–	Plantae
Subkingdom	–	Embryophyta
Phylum	–	Tracheophyta
Subphylum	–	Pteropsida
Class	–	Gymnospermae
Sub-class	–	Cycadophytae
Order	–	Cycadales
Family	–	Cycadaceae
Genus	–	*Cycas*

Distribution and Occurrence

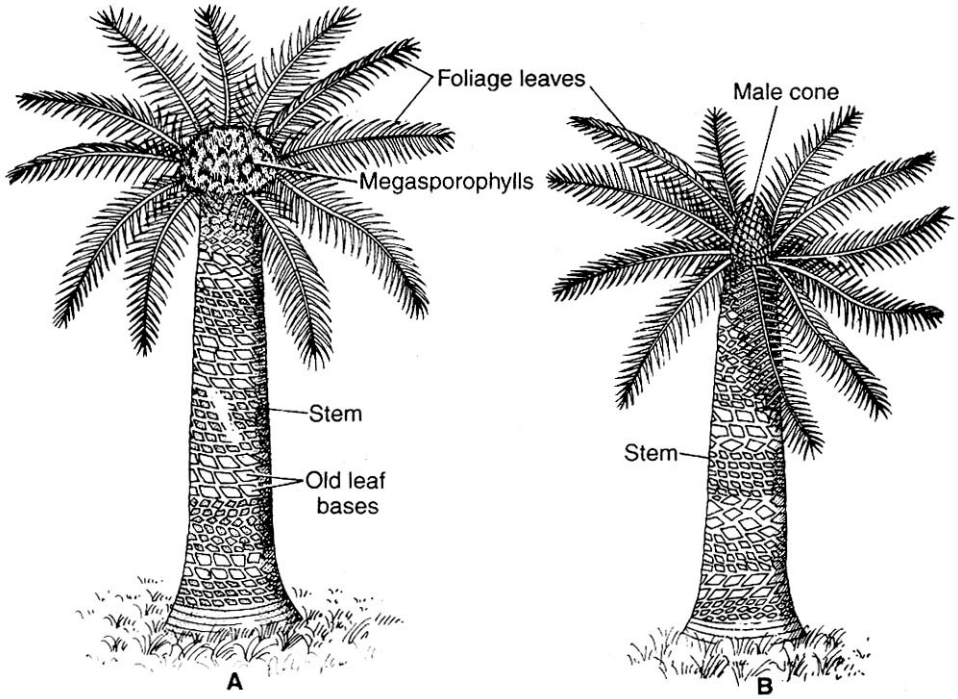
Cycas is an evergreen plant which looks like a palm. It has approximately 20 species.

In India *Cycas* species are common in Orisa, Bengal, Assam, Madras, Karnataka and Andmans. Four species are found in India.

Cycas revoluta, C. circinalis, C. rumphii and *C. beddomei*.

Salient Features

- Rich in mucilage.
- Coralloid roots beside normal root system.
- Circinate vernation of young leaflets (Ancestral fern character).
- Diploxylic Rachis and Leaflets.
- Polyxylic stem.
- Manoxylic wood.
- Microsporangia in sori (Ancestral fern character).
- Dioecious condition.
- Multiciliate, male gametes having spiral band of cilia (Ancestral fern character) in pollen tube, thus combination of **Zooidogamy** and **Siphonogamy**.
- Embryo with two cotyledons.
- Record of largest male one, microsporophyll, megasporophyll, ovule, egg and male gametes among all Gymnosperms.



Cycas cirnialis : A. Female plant, B. Male plant

EXTERNAL MORPHOLOGY

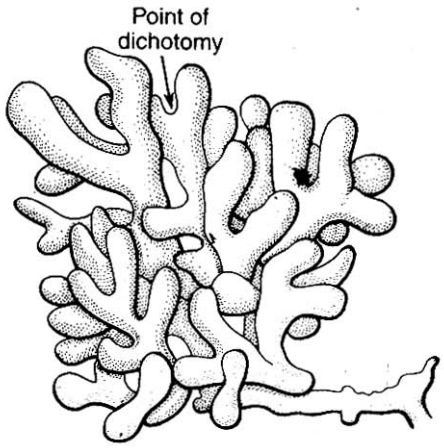
Fully grown plants attain a height of 2-5 metres although *Cycas media* attains a height of 20 metres. Plant body is divided into roots, stem and leaves.

Roots : There is a main tap root with lateral roots. Beside this normal root system there are dichotomously branched, bluish green coralloid roots. Blue green algae are found in their cortex. It is an example of symbiosis. Sometimes some bacteria and fungi also enter these roots. These roots are present near the soil surface.

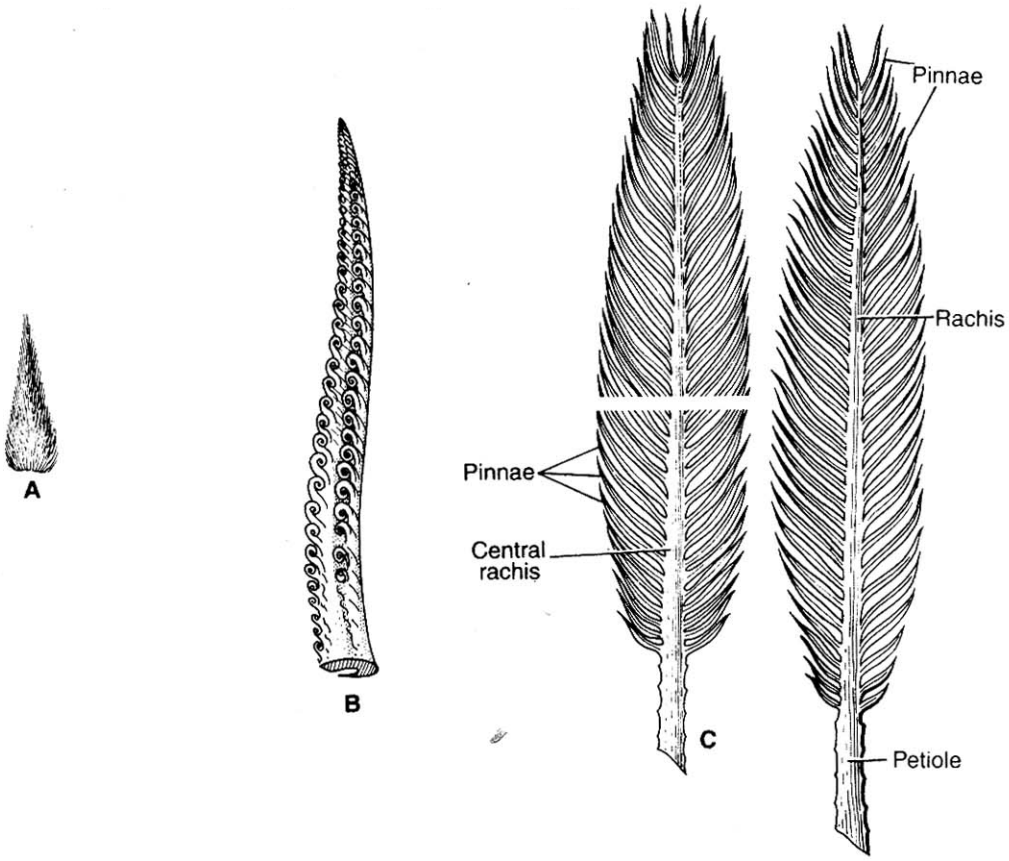
Stem : Stem is thick, cylindrical, columnar, small, aerial and unbranched. It is covered with presistent leaf bases. At the apex of the plant is present a crown of foliage leaves.

Leaves : *Cycas* has two types of leaves :

(a) Foliage leaves or megaphylls : These leaves are green, pinnately compound and spirally borne at the apex of the plant forming a crown.



***Cycas* : Coralloid roots**



***Cycas* : A. A scale leaf, B. A circinately coiled young foliage leaf, C. A fully expanded foliage (Break indicates that it is longer than shown here)**

Some leaflets at the base of rachis are modified into spines.

The vernation of young leaflets is circinate and is a primitive ancestral fern like feature. Older leaves die, leaving strong pointed basal rachis protruding out of the old stem. These are called armour of leaf bases.

(b) Brown small scale leaves or cataphylls : Borne in alternate whorl with the foliage leaves on young shoot apex.

ANATOMY

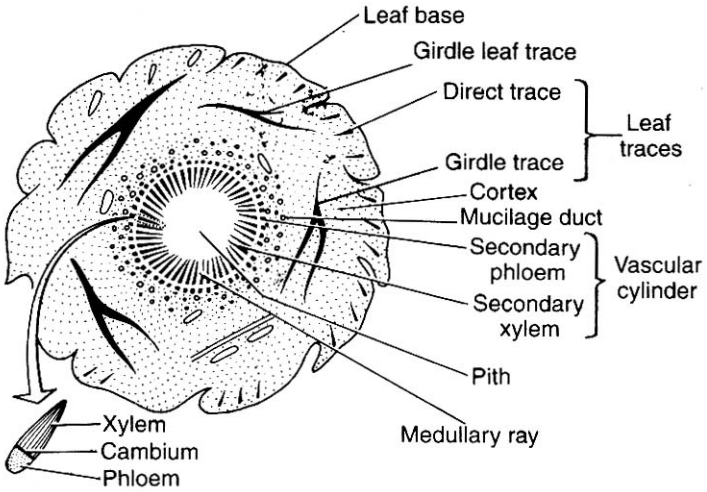
Cycas is rich in mucilage and anatomically schizogenous mucilage ducts are abundant in the plant body.

Stem

Resembles a dicotyledonous stem. The following tissues are differentiated :

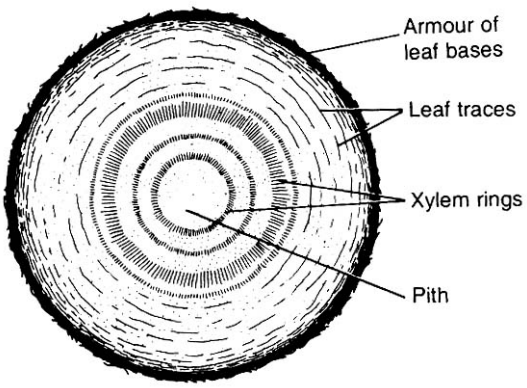
1. **Epidermis :** Outermost, incomplete, ruptured due to the presence of large number of leaf bases which are persistent (armour of leaf bases).
2. **Cortex :** Cortex is large, thin walled parenchymatous, numerous mucilage canals are present in the cortex. Large number of starch grains are found in the cortex.
3. **Endodermis and pericycle :** are not conspicuous.
4. **Stele :** Vascular cylinder is very small. It consists of numerous small closely arranged vascular bundles, which are conjoint, collateral and open. Xylem is endarch and consists of tracheids (no trachea). Phloem is without companion cells. Albuminous cella are present in phloem.

Pith : It is large, parenchymatous and contains a large number of mucilage canals. Large number of starch grains are found in the pith.

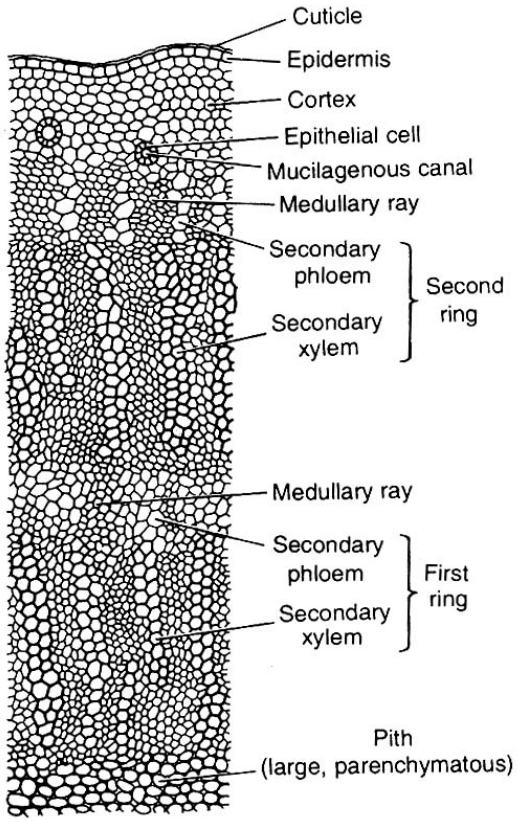


Cycas : An outline sketch of a T.S. of young stem with girdling leaf traces.

Secondary growth : It is abnormal and leads to the formation of several rings of vascular bundles. Due to ephemeral nature of cambia several accessory cambium rings develop one after the other when previous cambium stops function. At first a vascular cambium ring is formed in the same way as in dicot stems. The cambium ring divides in usual manner to form secondary xylem towards inner side and secondary phloem towards outer side. However, this cambium ring is short lived, therefore secondary cambium is formed from pericycle. This cambium ring produces secondary xylem towards inner side, the secondary phloem towards outside. After sometime this ring also becomes non functional. Another cambium ring is produced from cortex, again cutting off secondary xylem and secondary phloem as usual. In this way successive zones of secondary xylem and phloem alternating with parenchymatous tissue are formed. In *Cycas pectinata* as many as 14 rings have been reported. This type of condition of condition is called **polyxylic** condition (polycyclic). Secondary xylem trachieds shows characteristic multiseriate bordered pits.



***Cycas* : T.S. of old stem after secondary growth (polyxylic condition)**

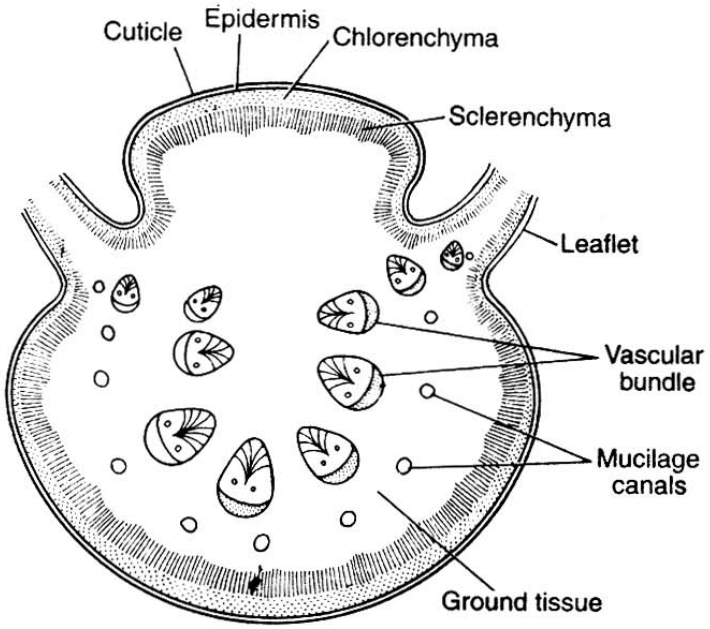


***Cycas* : Cellular structure of a part of T.S. of old stem**

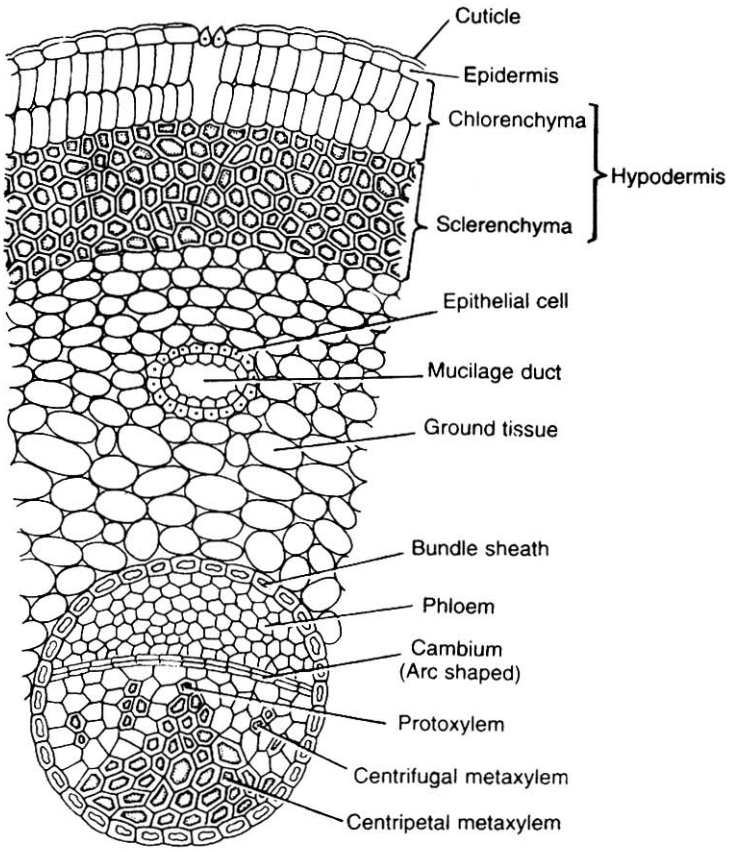
As the large amount of parenchymatous cells are interspersed with the secondary xylem tracheids wood is called **manoxylic wood.**
Prominent medullary rays are present in the vascular tissue.

Leaf

(a) Rachis : The outermost layer is epidermis with thick cuticle having interspersed sunken stomata. Below the epidermis two to three layered chlorenchymatous outer hypodermis is present.



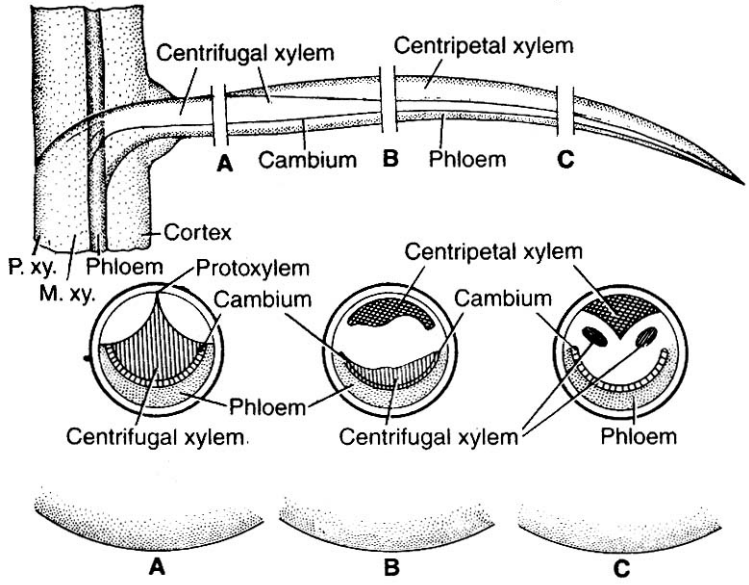
***Cycas* : T.S. of rachis showing moega-shaped ring of vascular bundles**



***Cycas* : A part of T.S. of rachis showing cellular structure**

Inner hypodermis is made up of some layers of sclerenchymatous cells. Hypodermis is followed by parenchymatous ground tissue with mucilage canals. The vascular bundles are arranged forming an inverted omega (Ω). Each vascular bundle is enclosed by a sclerenchymatous sheath. The vascular bundles are collateral and open. In most part of the rachis there is mesarch xylem, i.e., centripetal xylem (with metaxylem towards centre and protoxylem towards periphery and two patches of centrifugal xylem one on each side of protoxylem of centripetal xylem). Outside to the centrifugal xylem is cambium and then phloem (towards periphery). Due to two kinds of xylem it is called as **Diploxylic.**

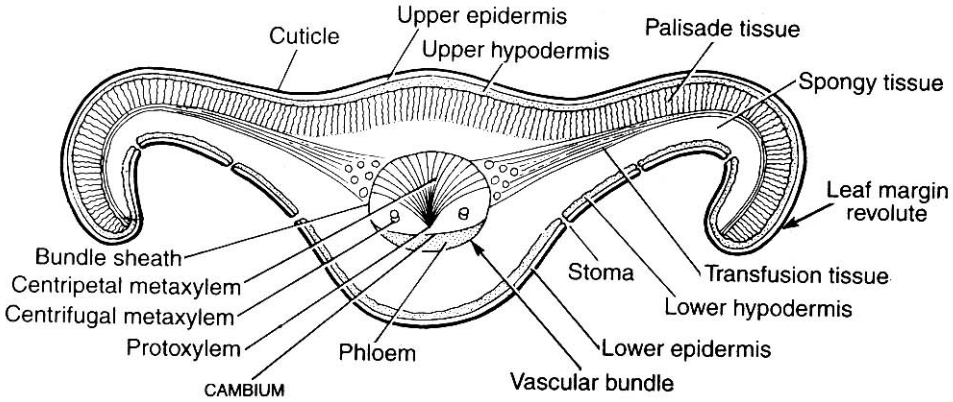
If we study the T.S. of rachis from base to apex, we find that only centrifugal xylem is present at the base and mesarch condition in most part of rachis and centripetal xylem only just at the apex.



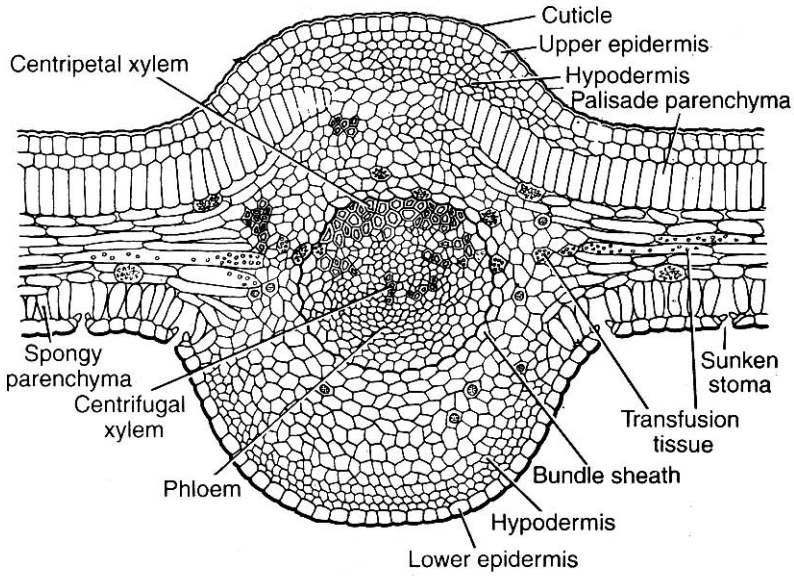
***Cycas* : Changing position and character of phloem and xylem from base to apex of rachis**

Leaflet : The margins of leaflet are curved downwards or revolute *Cycas revoluta.* The outermost layer is epidermis with thick cuticle. The lower epidermis is ruptured with sunken stomata. Just below the upper epidermis there are several continuous layers of sclerenchymatous hypodermis. Just above the lower epidermis sclerenchymatous hypodermis is present only in midrib portion. Mesophyll is differentiated into palisade (upper side) and spongy (lower side) tissue. Palisade tissue is made up of vertically elongated (in T.S.) cells without intercellular spaces. Palisade as well as spongy tissue contains large number of chloroplasts.

In the midrib there is a large vascular bundle. The vascular bundle is collateral and closed. The xylem is mesarch, (centripetal xylem with metaxylem and protoxylem above and two patches of centrifugal xylem on each side of protoxylem of centripetal xylem). Such an arrangement of centripetal and centrifugal xylem is called **diploxylic** condition. On each side of mthe midrib in between the palisade and spongly tissues is present transfusion tissue made up of horizontally arranged tracheids which supply water and mineral to palisade and spongy tissue up to margins. It is also called as **hydrostereom.** Pilger called it **radial parenchyma**.



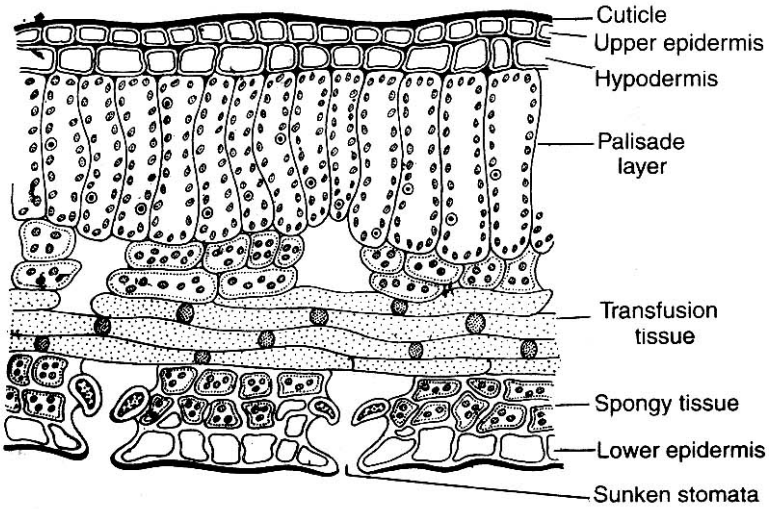
***Cycas* : Outline sketch of the T.S. of leaflet**



***Cycas* : A part of T.S. of leaflet showing detailed structure of midrib**

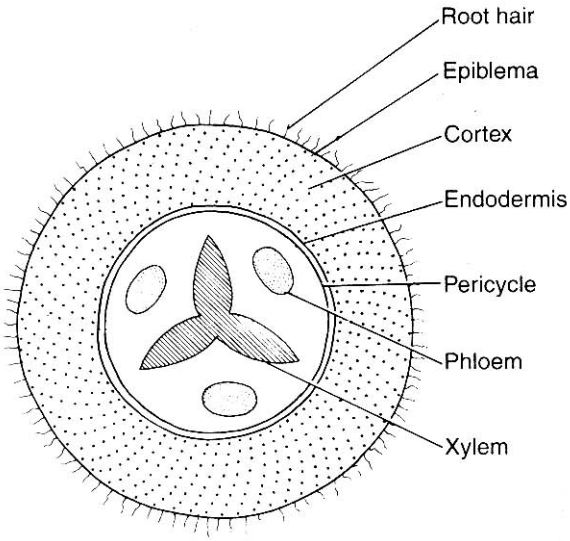
Root

1. **Normal Root :** The structure of normal root resembles dicotyledonous root. The outermost layer is epiblema with root hairs. Just below the epiblema is present multilayered parenchymatous cortex. Intermingled in cortex are some tannin cells. Below the cortex is endodermis, made up of barrel shaped cells and just below the endodermis is a layer of pericycle. Roots are diarch, triarch and

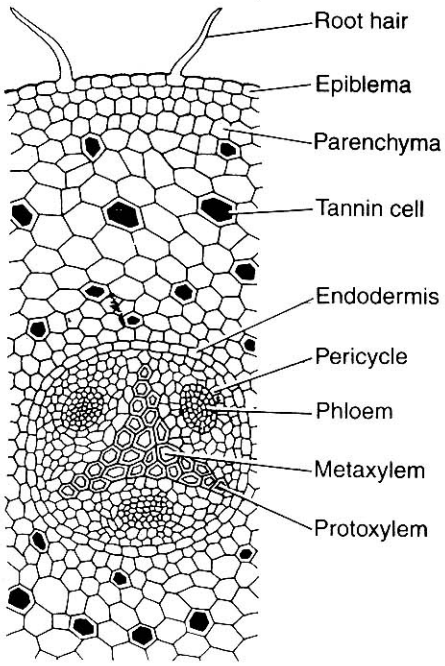


***Cycas* : A part of T.S. of the leaflet showing mesophyll, cuticle, sunken stomata and transfusion tissue**

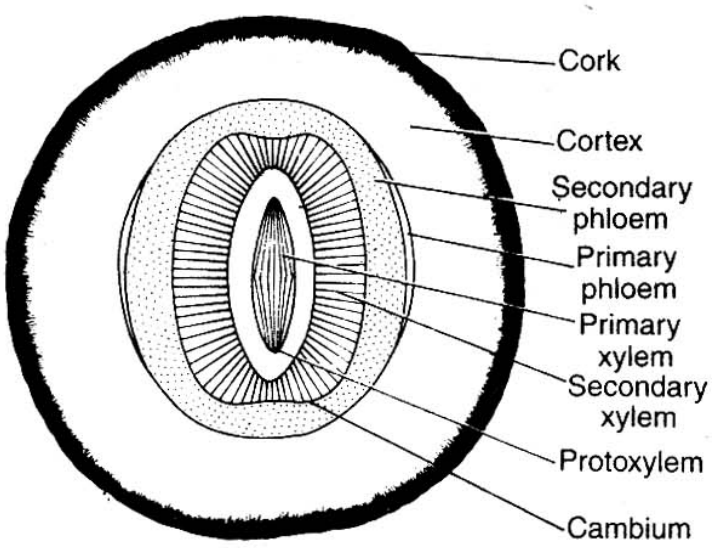
Sometimes polyarch. Xylem is exarch. Vascular bundles are radial. Pith is absent. Secondary growth in roots is like dicotyledonous plants.



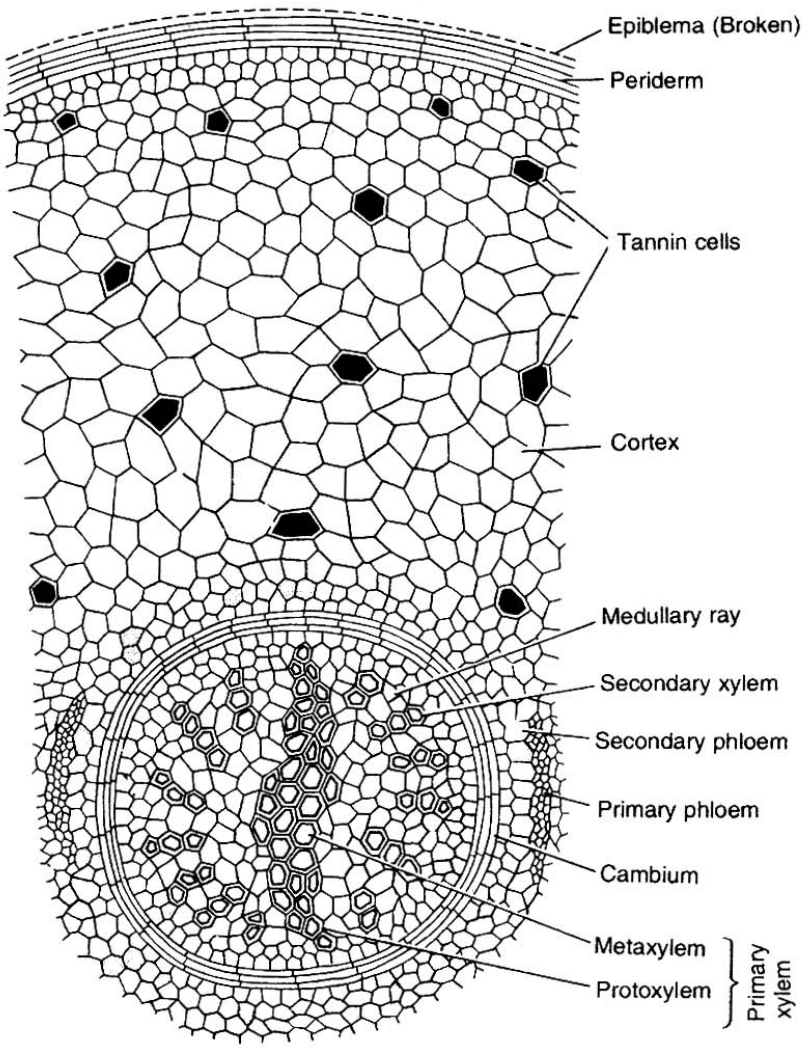
***Cycas* : Outline sketch of T.S. of a normal root (triarch)**



***Cycas* : Cellular structure of a part of T.S. of a normal triarch root**

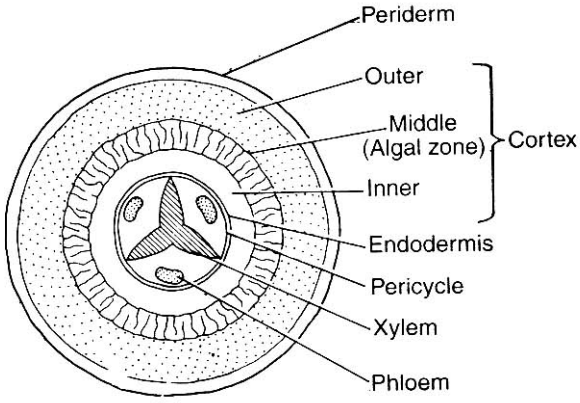


Cycas **: Outline sketch of T.S. of a normal diarch root with secondary growth**

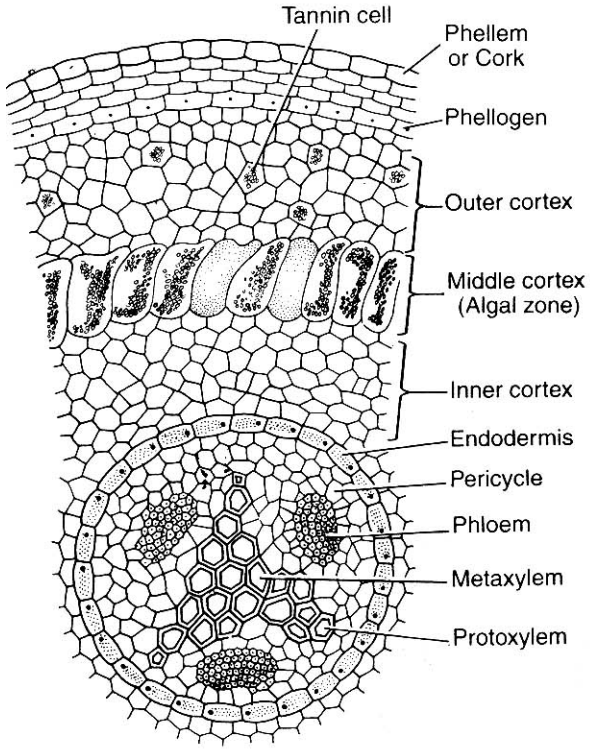


Cycas **: Cellular structure of T.S. of a normal diarch root with secondary growth**

2. **Coralloid root :** The structure of stele is similar to normal roots but cortex is differentiated into three zones. Outer cortex with several layers of parenchymatous cells. Middle cortex filled with blue-green algae *Anabaena* and *Nostoc* (Algae zone) and inner cortex of several layers of parenchymatous cells. These algae are symbiotic in nature.



***Cycas* : Outline sketch of T.S. of triarch coralloid root**



***Cycas* : Cellular structure of a part of T.S. of triarch coralloid root**

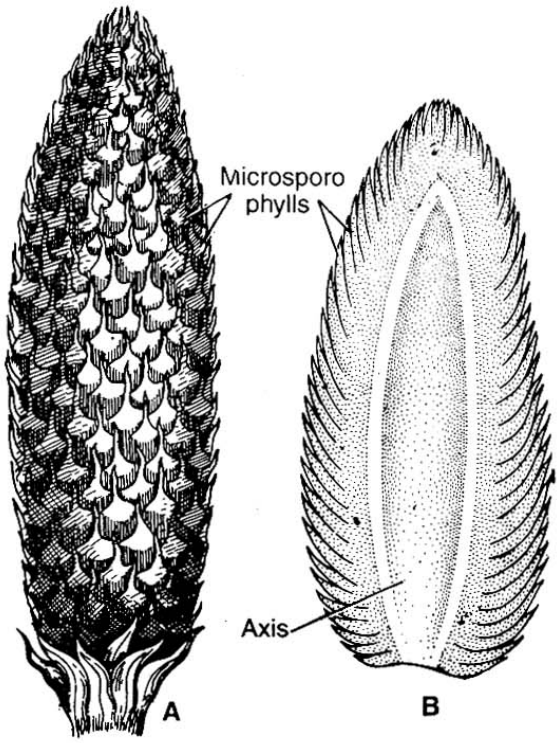
REPRODUCTION

1. Vegetative Reproduction

Bulbils (resting adventitious buds) are produced on the stem in the axil of scale leaves. They break up from the parent plant and germinate to give rise to new plant.

2. Sexual Reproduction

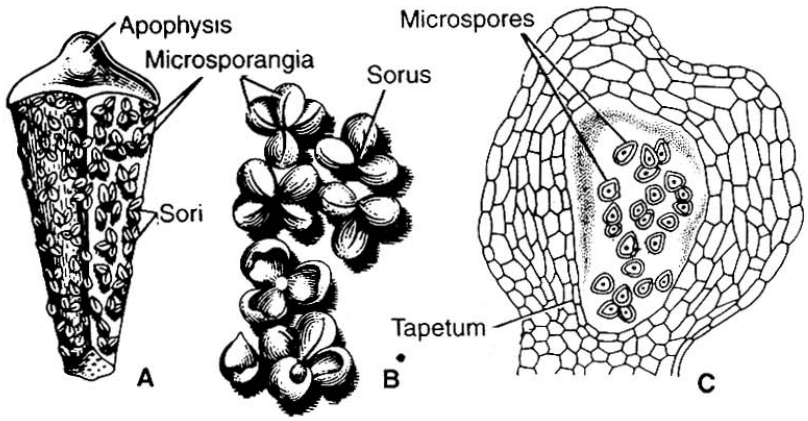
Plants are dioecious. Male plants are less in number and also shorter than female plants. They bear male strobilus or male cone (Staminate strobilus = microsporangiate strobilus). The male cone is produced at the apex and is on an average 20 cm, (longest reported 45 cm) long. The cone being terminal, the apical growth of stem is stopped, temporarily. The cone is later pushed to one lateral side and the stem continues to grow by lateral bud which become terminal and thus the shoot of male plant represent a **sympodium.**



***Cycas* : A. Entire male cone, B. Male cone in L.S.**

Each male cone is long, compact, fusiform. It consists of a number of microsporophylls arranged spirally in acropetal succession on a central axis.

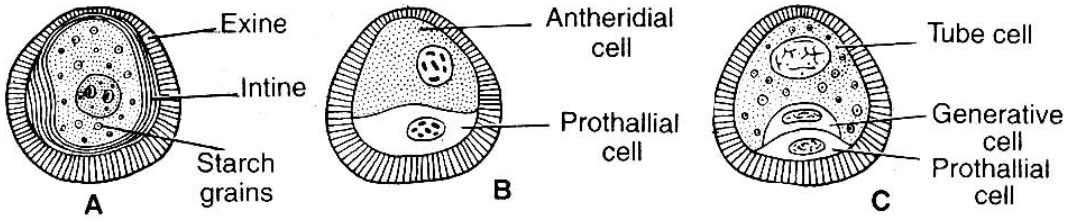
The structure of microsporophyll varies with species. It is a flattened structure, narrow below and broadened above into an expanded sterile apex. On the lower surface of microsporophyll are borne numerous microsporangia in sori of 2-6. The total number of microsporangia on a single microsporophyll are 900-1000. Each microsporangium is a globular, saclike structure. It consists of a large number of microspores (pollen grains) formed from microspore mother cells, after reduction division. Each microspore has an outer wall called exine which is thin at one end and thick at other places. The inner wall of microspore called intine is thin. Microspore is the first cell of the



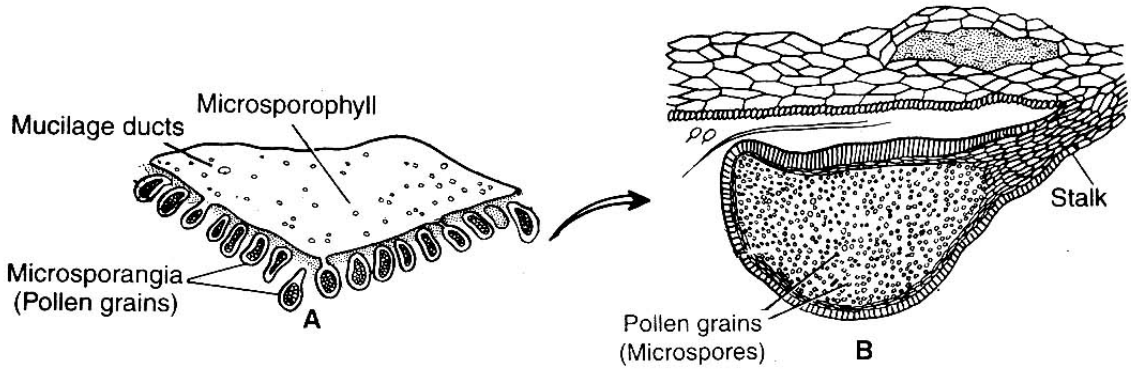
***Cycas* : A. One microsporophyll, B. Sori of microsporangia, C. L.S. of single microsporangium**

male gametophytic generation and its germination starts while the microspores are still enclosed in the microsporangium wall.

Development of male gametophyte prior to pollination : At first a small vegetative cell or prothallial cell is cut off at one end, leaving a large antheridial cell. The antheridial cell again divides into a small generative cell in contact with prothallial cell and a large tube cell. At this three celled stage the microspore are shed from the microsporangium, which bursts through a slit.



***Cycas* : A-B, Development of male gametophyte before shedding, C. Shedding stage**



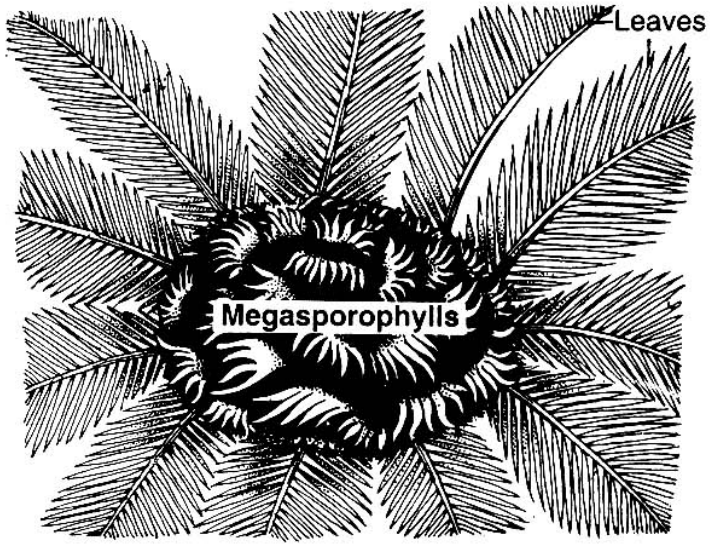
***Cycas* : A. T.S. of one microsporophyll, B. Single microsporangium in L.S.**

Female (=ovulate)

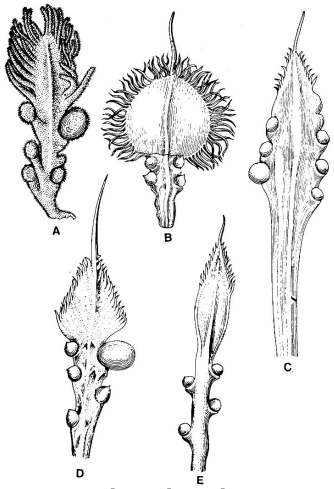
reproductive structures

The female reproductive structure is rosette of megasporophylls arising spirally in acropetal succession and loosely arranged on the stem apex of female plant.

Each megasporophyll resembles a reduced foliage leaf. The apical part of megasporophyll is leafy, sterile, pinnately divided part (*C. revoluta*) and just below it a fertile stalk which bears 2-4 pairs of ovules (megasporangia) attached laterally. Both the ovules and sporophylls are covered by a thick coat of yellow, wooly hairs but as the ovules get large, these hairs are lost so that the ripe seeds have orange-red colour.



***Cycas revoluta* : Large megasporophylls at the apex of female plant.**

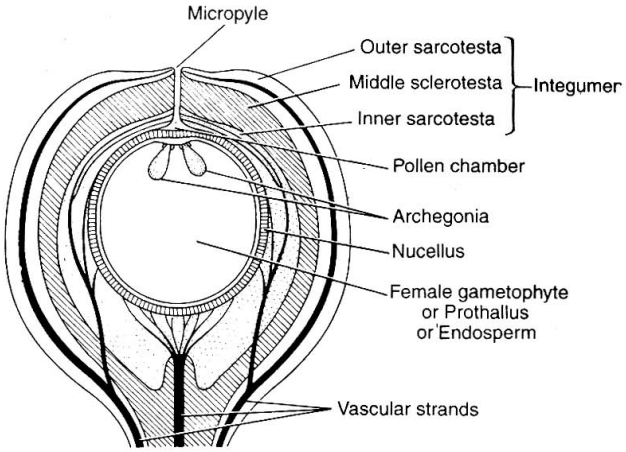


***Cycas* : Different species showing megasporophylls :**
A. *C. revaluta*, B. *C.pectinata*, C. *C. circinalis*, D. *C. rumphii*, E. *C. beddomei*

In certain species, e.g., *C. circinalis* there is a reduction in the number and size of the sporophylls and reduction of the leaflets, until the sporophyll has a serrate margin and reduction in the number of ovules to a single pair.

Megasporangium (= ovule) : The ovules are erect. The main body of the ovule is nucellus covered over by a single thick integument except at the apex of ovule where integuments are absent. This point is called micropyle. The apex of the nucellus develops a beak like process, the nucellar beak, projecting into the micropyle.

The integument is very thick. It is free from nucellus in the region of nucellar beak. In mature ovule it can be differentiated into three layers : 1. Outer fleshy layer of red colour, 2. middle stony layer, 3. inner fleshy layer. The inner fleshy layer is absorbed later by the developing female gametophyte. The outer and inner fleshy layers are provided with large number of vascular bundles.



***Cycas* : L.S. of ovule (megasporangium)**

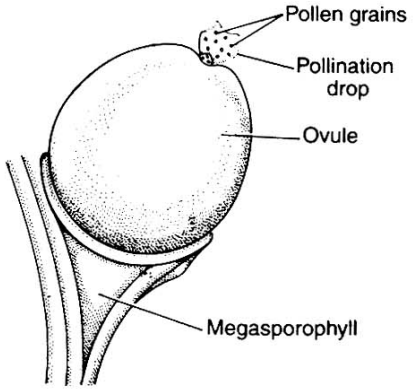
Development of female gametophyte (= endosperm) : A spore mother cell is differentiated deep within the nucellus. It divides twice to form a linear tetrad of megaspores of which three of micropylar end degenerate. The lowermost megaspore is the first cell of female gametophyte. It enlarges considerable by absorbing some of the nucellus cells. The megaspore nucleus divides repeatedly by free nuclear division and a vacuole appears in the centre and many free nuclei are embedded in the surrounding cytoplasm. Later a parietal tissue is formed by wall formation which proceed from periphery to centre, leading to the formation of **prothallus or female gametophyte or endosperm.** This tissue later on provides food for the developing embryo.

Structure of archegonium : Some of the peripheral cells of the female gametophyte towards the microphylar end become larger and function as archegonial initials. Usually 3-6 archegonia develop on one female gametophyte. Each archegonium at maturity has two neck cells, a ventral canal nucleus and structure and disorganizes soon. Neck canal cells are absent.

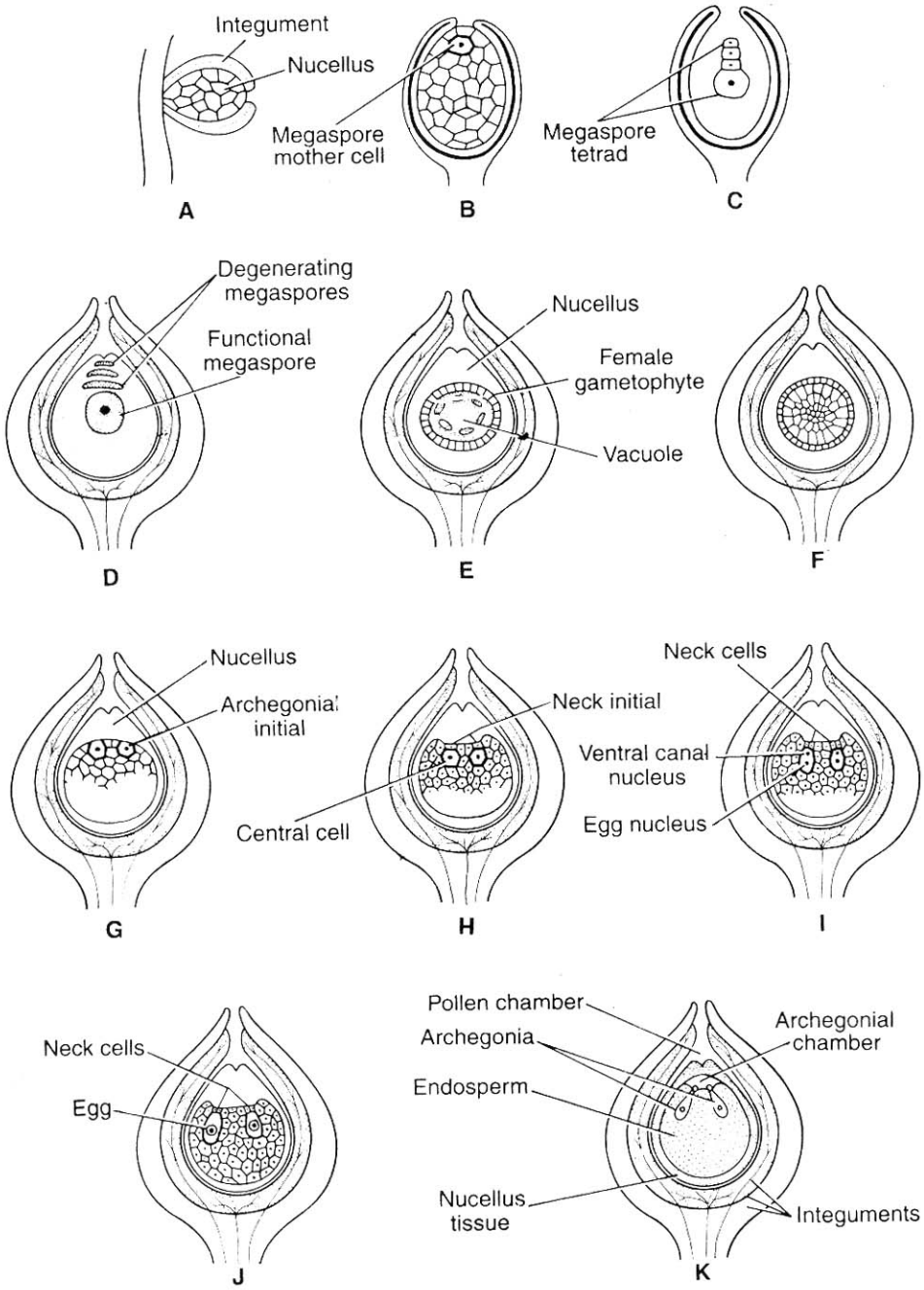
Owing to the checking of the growth of the prothallus in the archegonial region, the group of archegonia become situated at the bottom of depression called archegonial chamber in which the nucellus degenerates forming a liquid into which the neck of archegonia open.

Pollination

The pollen grains of *Cycas* are light and easily blown away by wind in three celled stage. At the time of pollination a large pollination drop oozes out of micropylar end of ovules by disorganization of nucellar beak. The pollen grains fall on this drop and as it dries up, the pollen are drawn into a chamber below. This chamber is called **pollen chamber.**

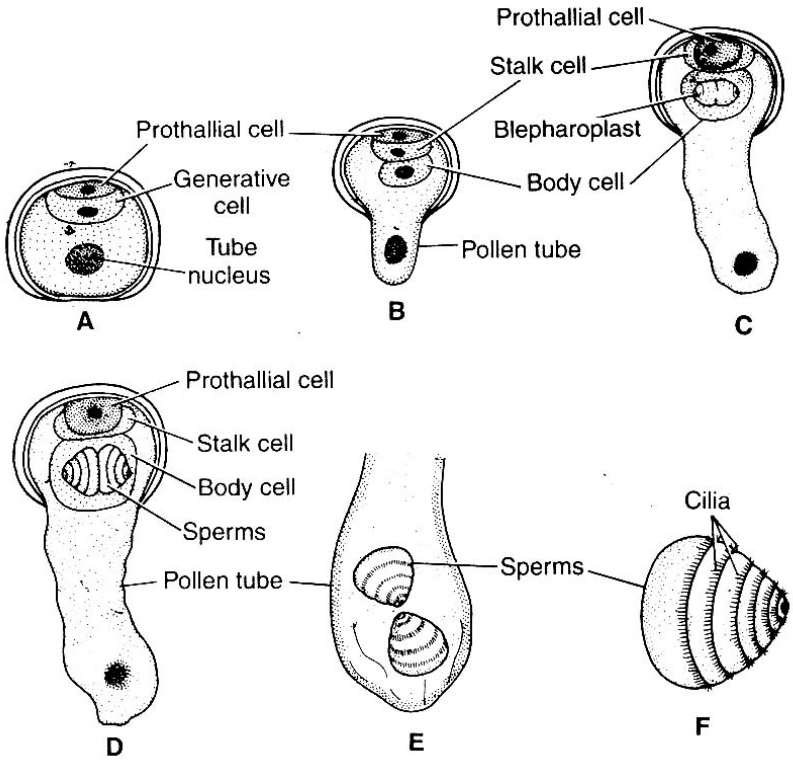


Cycas numphii **: An ovule with pollination drop**

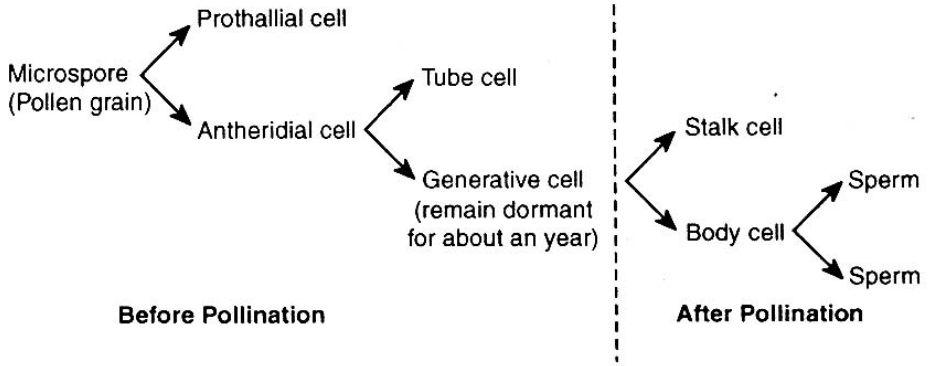


Cycas **: Different stages in the development of female gametophyte**
A. Ovule in early stage, B. Appearance of megaspore mother cell, C. Megaspore mother cell devides reductionally to form four megaspore, D. Three megaspores degenerate, one remain functional, E to J. Development of female gametophyte and archegonia, K. Mature ovule

Germination of pollen grain and formation of male gametes : Once the pollen grains are in the pollen chamber they absorb water and begin to germinate. The tube cell elongates and pierces the exine forming a pollen tube. The apex of pollen tube is slightly swollen and branched. The pollen tube acts as haustorium absorbing food from nucellus. The generative cell divide into two, the stalk cell and body cell. Body cell enlarges and forms several blepharoplasts which later form many cilia. The body cell divides into two daughter cells just before fertilization. Each daughter cell metamorphoses into one male gamete or antherozoid. The male gametes of *Cycas* are the largest (as copared to other plants as well as animals) and are visible to naked eye and are oval in form (top-shaped), broad and naked at posterior end and spirally coiled in the anterior half with thousands of



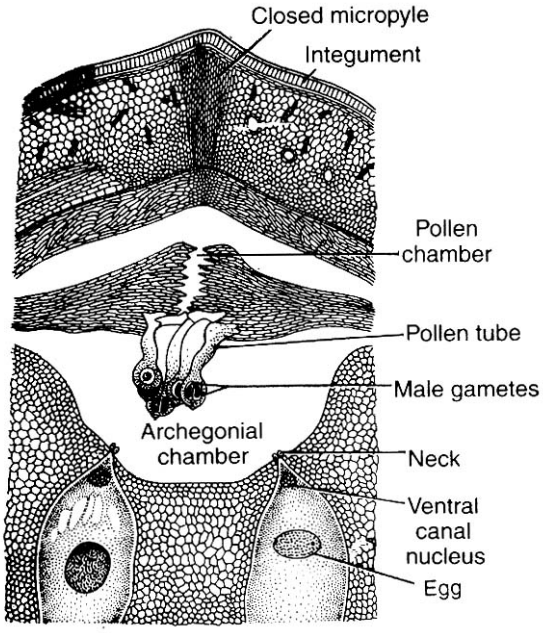
***Cycas* : Structure and development of male gametophyte**



***Cycas* : Outline of successive stages in development of male gametophyte**

small cilia emerging from the spiral grooves. The sperms first swim in the cavity of the body cell and later pass into pollen tube and reach the tip of the pollen tube.

Fertilization : It occurs after four to six months of pollination. During this period, formation of male gametes (antherozoids) take place. In this process pollen tube containing the tube nucleus and two sperms, becomes turgid and bursts thus discharging its contents into the liquid of the archegonial chamber. The archegonium also become turgid and discharges its contents thus separating the two neck cells through which the single male gamete is drawn inside archegonium. The cilia and membrane of the sperm slips off and cytoplasm and nucleus fuses with the egg forming **oospore**. Prothalial cell, tube nucleus, stalk cell degenerate after sometime.



***Cycas* : L.S. of upper part of ovule showing course of pollen tubes**

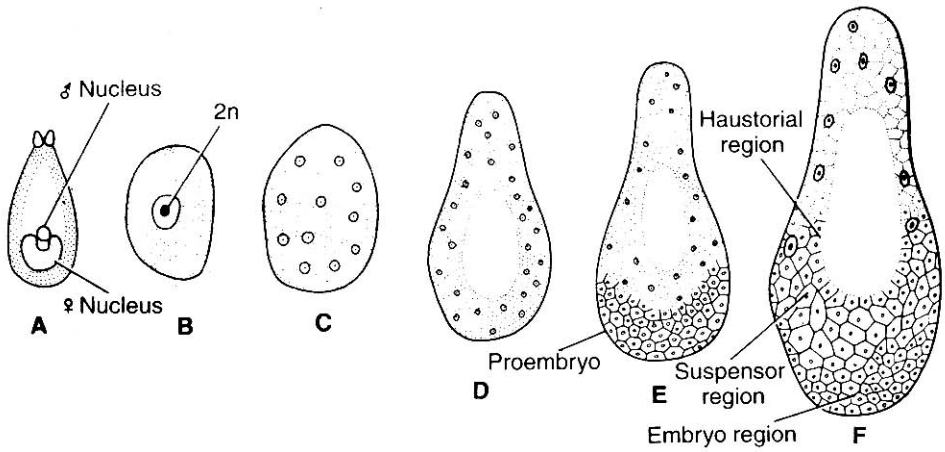
Embryology

The oospore is the first cell of the sporophytic generation. It single nucleus divides repeatdly by free nuclear division which are situated in peripheral region of oospore with a central vacuole. Wall formation takes place from periphery to centre in the lowr end only which is now called **embryonal mass.** The embryonal mass is distinguished into three zones :

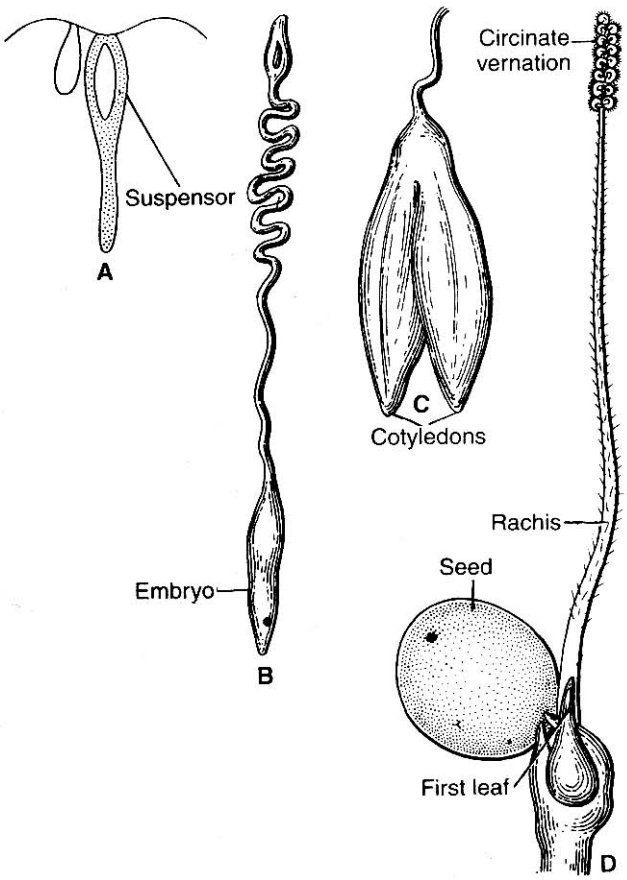
1. Haustorial zone,
2. Suspensor zone,
3. Proembryo

Proembryo forms almost all parts of embryo. Suspensor layer elongates and pushes the proembryo down into the food laden tissue of the gametophyte. Suspensors continue to elongate till they form an exceedingly long, tortuous and often spirally coiled structure. Proembryo forms, plumule and two cotyledons. Tip of suspensor forms radicle.

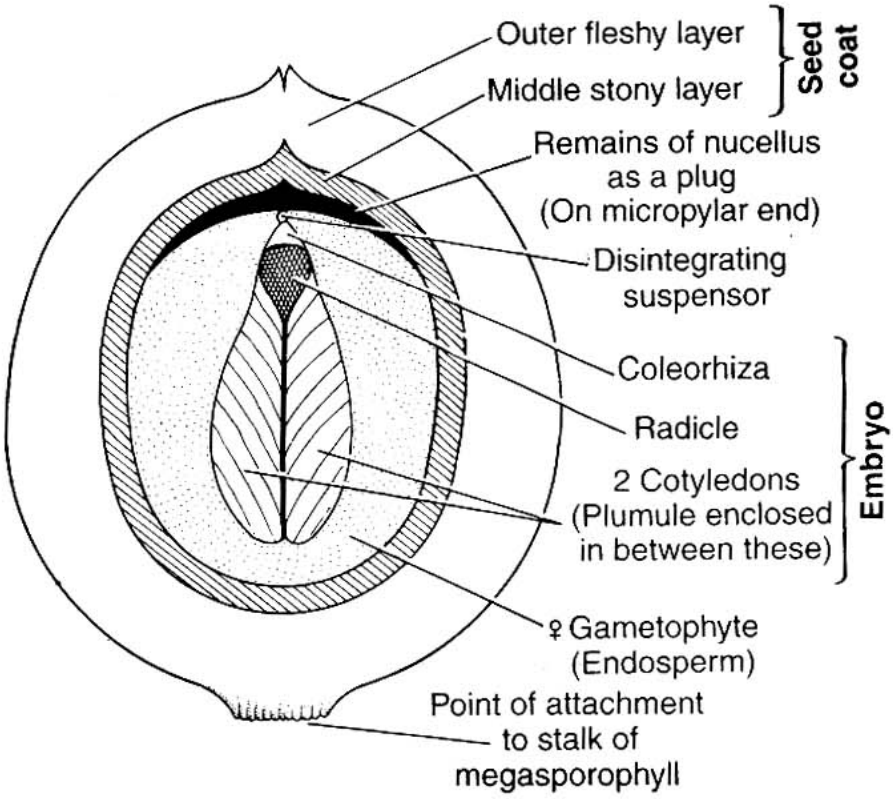
As there are several archegonia, several developing embryos may be found in one young seed (polyembryony) but only remains at maturity and others perish.



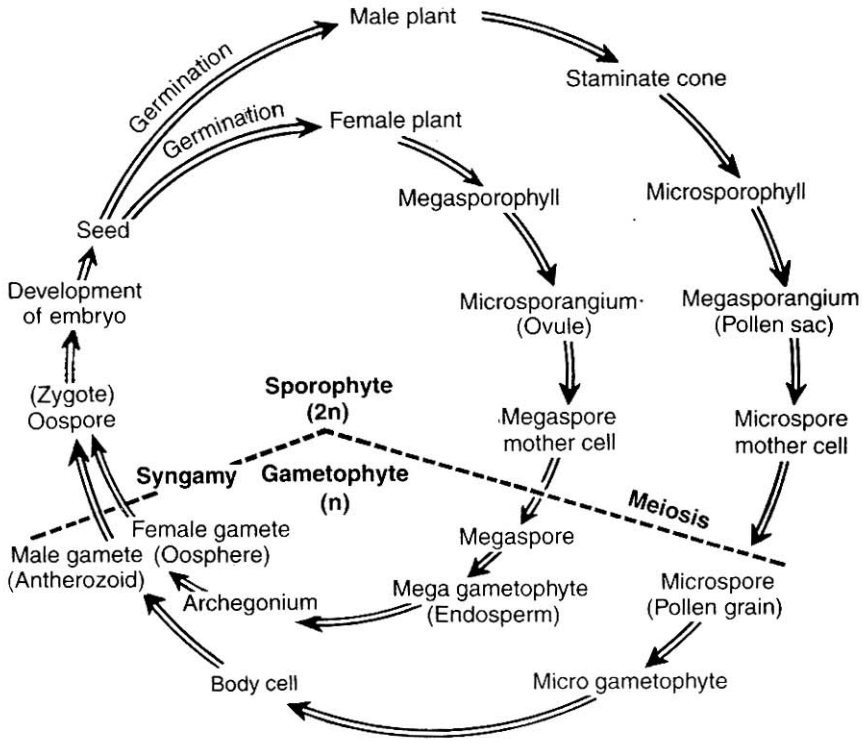
***Cycas* : Showing fertilization and early stages in the development of embryo**



Cycas **: A-C Stages in the formation of embryo, D. Young seedling with circinate vernation of leaf**



Cycas **: L.S. of seed**



***Cycas* : Topographical representation of life cycle**

Seed formation : As a result of post-fertilization changes in the ovule, it is transformed into a seed. The following changes takes place in this process :

	Ovule	**Seed**
1.	Integuments	Seed coat
(a)	Two outer layers of integument	
	(i) Outer fleshy layer which becomes cream, orange or red coloured	
	(ii) Middle stony layer	
(b)	Inner fleshy layer	Absorbed by developing gametophyte
2.	Nucellus	Present in the form of a cap towards micropylar end (absorbed by developing gametophyte at other places)
3.	Female gametophyte	Endosperm
4.	Zygote	Embryo with radicle, plumule and two cotyledons

Germination of Seed

The germination of *Cycas* seed is **epigeal.** In germination, the radicle grows down and forms a tap root. The cotyledons remain inside seed coat which comes out above the surface of soil. This is the reason why some authors write that it is partly hypogeal and partly epigeal. The plumule grows above ground and first form some scale leaves and leaves and later pinnate foliage leaves.

Following three generations are present in a *Cycas* seed :

1. **Old sporophyte :** Seed coat and nucellus
2. **Female gametophyte :** Endosperm
3. **Future sporophyte :** Embryo (radicle, cotyledons and plumule)

Economic importance of *Cycas*

1. A starch called sago is obtained from the pith of *Cycas rumphii* that is why *Cycas* is also called sago palm.
2. Seed of some cycads are used as fodder for animals.
3. Boiled seed of *Cycas rumphii* are eaten by inhabitants of Andamans.
4. Leaves are used for making mats.
5. *Cycas revoluta* is an ornamental plant.
6. Boiled young leaves are eaten as vegetables.

EXERCISE

Q.1 *Ulothrix* occur in –

(1) Warm stagnant waters (2) Slow flowing cold waters

(3) Slow flowing warm waters (4) Warm saline waters

Q.2 Lithophytic species of *Ulothrix* is –

(1) *U. amplexa* (2) *U. flacca* (3) *U. flaccida* (4) *U. zonata*

Q.3 Filaments of *Ulothrix* are –

(1) Brick shaped (2) Branched (3) Girdle shaped (4) Unbranched

Q.4 The shape of a vegetative cell of *Ulothrix* is –

(1) Rounded (2) Rectangular (3) Cylindrical (4) Spherical

Q.5 How many chloroplasts occur in *Ulothrix* –

(1) One girdle shaped (2) Two star shaped (3) Three cup shaped (4) Many spiral shaped

Q.6 In *Ulothrix* food is stored in the form of –

(1) Protein (2) Starch (3) Pyrenoid (4) Lipid

Q.7 In *Ulothrix* the food storage structure pyrenoid is present in –

(1) Cytoplasm (2) Vacuole (3) Mitochondria (4) Chloroplast

Q.8 Microzoospores in *Ulothrix* are –

(1) Biflagellate only (2) Quadriflagellate only (3) Both (4) Multiflagellate

Q.9 When environmental condition becomes semidrying the *Ulothrix* porduces –

(1) Akinete (2) Zoospore (3) Gametes (4) Palmella

Q.10 A motile spores related to asexual reproduction in *Ulothrix* is –

(1) Zygospore (2) Zoospore (3) Hypnospore (4) Akinete

Q.11 Thin walled non motile spores of algae are termed –

(1) Aplanospores (2) Azygospores (3) Zygospores (4) Akinete

Q.12 The gametangia and sporangia of *Ulothrix* (algae) are –

(1) Jacketed and unicellular (2) Non–jacketed and unicellular

(3) Jacketed and multicellular (4) Non–jacketed and multicellular

Q.13 What type of sexual fusion or sexual reproduction occurs in *Ulothrix* –

(1) Isogamous (2) Anisogamous (3) Agamous (4) Conjugation

Q.14 Which of the following is found during parthenogenesis in *Ulothrix* –

(1) Oosphere and zoospres (2) Oospore (3) Azggospore (4) Cyst and palmella

Q.15 Parthenogenesis in *Ulothrix* forms a resting structure called –

(1) Zygospore (2) Azygospore (3) Hypnospore (4) Zoospore/Akinete

Q.16 *Albugo Candida*, the agent of white rust disease is a –

(1) Protist (2) Microbe (3) Fungus (4) Prokaryote

Q.17 White rust of crucifers is caused by –

(1) *Cystopus* (2) *Ustilago* (3) *Puccinia* (4) *Aspergillus*

Q.18 Why *Albugo* is a fungus ? because –

(1) It is a heterotrophic thallophyte (2) Its reserve food is glycogen and oil

(3) Its wall material is chitin (4) All of the above

Q.19 Mycelium of *Albugo* is –

(1) Intracellular and coenocytic (2) Intercellular and coenocytic

(3) Intracellular and uninucleate (4) Intercellular and uninucleate

Q.20 The wall of the hyphae of fungi is made up of –

(1) Pectin (2) Chitin + Cellulose

(3) Hemicellulose and chitin (4) Chitin + Murein

Q.21 *Albugo* is –

(1) Obligate intercellular pathogen (2) Intracellular parasite

(3) Intercellular saprophyte (4) Facultative intercellular parasite

Q.22 Nutritionally *Albugo* is a –

(1) Saprophyte (2) Facultative parasite (3) Obligate parasite (4) Facultative saprophyte

Q.23 In what form the food is stored in the mycelium of a fungus (Or) *Cystopus* –

(1) Sugar, oil and mannitol (2) Starch and protein

(3) Protein and cellulose (4) Glycogen (animal starch) and oil

Q.24 Which part of the plant is not affected by *Albugo* –

(1) Stem (2) Root (3) Leaf (4) Flower

Q.25 Most common method of asexual reproduction in *Albugo* by –

(1) Zoosporangia (2) Aplanospores (3) Conidiosporangia (4) Zygospore

Q.26 The flagella on the zoospore of *Albugo* are –

(1) Equal lateral (2) Equal terminal (3) Unequal terminal (4) Unequal lateral

Q.27 The flagella on the zoospore of *Albugo* are –

(1) Whiplash type (2) Tinsel type

(3) One whiplash and one tinsel (4) Mixed type

Q.28 Hypertrophy of floral parts in a cruciferous plant is caused by –

(1) Conidia of *Cystopus*

(2) Conidiophores of *Cystopus*

(3) Accumulation of hyphae of *Cystopus* for sexual reproduction

(4) All of the above

Q.29 Female reproeductive structure or gametangium of *Albugo* is –

(1) Pistil (2) Archegonium (3) Ascogonium (4) Oogonium

Q.30 Sexual reproduction or fertilization can occur without water in –

(1) *Ulothrix* (2) *Albugo* (3) *Cycas* (4) Fern/*Pteridium*

Q.31 What is the most economic method of the control of white rust disease of crucifers ?

(1) Soil fumigation (2) Crop rotation (3) Use of fungicides (4) Use of antibiotics

Q.32 Crop rotation kills –

(1) Soil inhabitants (2) Soil minerals (3) Host (4) Obligate parasites

Q.33 Aquatic bryophytes are –

(1) *Riccia fluitans*/*R.natans* (2) *R. discolor* (3) *R. robusta* (4) *R. prostrata*

Q.34 *Riccia* is an example of –

(1) Thallophyta (2) Embryophyta (3) Pteridophyta (4) Spermatophyta

Q.35 Gametophytic generation is most developed or dominant in –

(1) Bryophytes (2) Pteridophytes (3) Gymnosperms (4) Angiosperms

Q.36 What is the function of the ventral scales of *Riccia* –

(1) Fixation (2) Protection

(3) Absorption and protection (4) Perenation and protection

Q.37 Rhizoids of *Riccia* are –

(1) One type and scattered (2) One type and arranged in rows

(3) Two types and scattered (4) Two types and arranged in rows

Q.38 The rhizoids of *Riccia* are –

(1) Multicelled, smooth and tuberculated type

(2) Multicelled and tuberculated

(3) Unicelled unbranched smooth walled and tuberculated type

(4) Unicelled branched and smooth walled type

Q.39 Jacket of *Riccia* gametangium is –

(1) Unicellular and one layered (2) Multicellular and one layered

(3) Unicellular and multilayered (4) Multicellular and multilayered

Q.40 Antherozoids of *Riccia*, *Marchantia* and other bryophytes are –

(1) Rod shaped and biciliate (2) Short curved and biciliate

(3) Short, curved and multiciliate (4) Long, curved and multiciliate

Q.41 Sporogonium of *Riccia* possess –

(1) Foot and seta (2) Foot and capsule

(3) Foot seta and capsule (4) Only capsule

Q.42 In *Riccia* –

(1) Sporophyte remains parasitic over its gametophyte (2) Gametophyte is parasitic over its sporophyte
(3) Sporophyte is a partial parasite (4) Sporophyte is independent of the gametophyte

Q.43 In *Riccia* meiosis occurs during –

(1) Gamete formation (2) Spore formation (3) Oospore germination (4) Oospore formation

Q.44 Sporogonium of *Riccia* is –

(1) Jacketed and eusporangiate (2) Non–jacketed and eusporangiate

(3) Jacketed and leptosporangiate (4) Non–jacketed and leptosporangiate

Q.45 How does the dehiscence of sporogonium and dispersal of spores occur in *Riccia* –

(1) By internal pressure of elaters

(2) By death and decay of thallus and sporogonium and external pressure on calyptra

(3) By peristome teeth and seta

(4) By shrinking of annulus and explosion of capsule

Q.46 Spores of *Riccia* are –

(1) Smooth and rounded (2) Smooth and tetrahedral

(3) Spiny and rounded (4) Spiny of Tough and tetrahedral

Q.47 The gametophase of *Riccia* ends with –

(1) Gamete (2) Spore mother cells (3) Spore (4) Oospore

Q.48 Gemmae on *Marchantia* are produced on –
(1) Dorsal groove (2) Ventral face (3) Lower face (4) Middle part

Q.49 *Pteridium*/*Dryopteris*/*Nephrolepis* (Fern) is –
(1) A bryophyte (2) A pteridophyte (3) A liverwort (4) An spermatophyte

Q.50 Which of the following is known as walking fern –
(1) *Ophioglossum* (2) *Pteris* (3) *Pteridium* (4) *Adiantum*

Q.51 The most important characteristics of a fern plant is –
(1) Circinate pinnules (2) Photosynthetic sporophyll
(3) Compound leaves (4) Spores in sporangia

Q.52 The vernation or uncoiling of leaf of *Pteridium* is –
(1) Replicate (2) Circinate (3) Conduplicate (4) Convolute

Q.53 Which of the following venation is characteristic of fern –
(1) Parallel (2) Reticulate (3) Open furcate (4) Closed dichotomous

Q.54 A stele having leaf gaps to produce many smaller meristeles is known as –
(1) Dictyostele (2) Solenostele (3) Siphonostele (4) All of the above

Q.55 The stele of *Pteridium* root is –
(1) Diarch exarch (2) Diarch endarch (3) Polyarch exarch (4) Polyarch endarch

Q.56 In fern rhizome –
(1) Tracheids are absent (2) Vessels are absent
(3) Sieve tubes are absent (4) Phloem parenchyma is absent

Q.57 Sorus bearing leaf of *Pteridium* is called –
(1) Ramenta (2) Indusium (3) Sporophyll (4) None of the above

Q.58 In *Pteridium* the sori are present on –
(1) Upper side of the leaf and marginal (2) Upper side and superficial
(3) Lower side of the leaf and marginal (4) Lower side of the leaf and superficial

Q.59 Indusium in *Pteridium* is –
(1) Outer true and inner false (2) Only true
(3) Outer false and inner true (4) Only false

Q.60 How many spores are produced by a fern sporangium –
(1) 16 (2) 32 (3) 64 (4) 128

Q.61 Spores of fern are –
(1) Haploid (2) Diploid (3) Triploid (4) Polyploid

Q.62 In fern, the phase started by spore ends in –
(1) Sporocytes (2) Oospore (3) Prothallus (4) Gametes

Q.63 Gametophyte of *Pteridium* is –
(1) Thallus (2) Prothallus
(3) Antheridium and archegonium (4) Potted herb

Q.64 The neck of a fern archegonium contains –
(1) Four neck canal cells (2) Three neck canal cell
(3) One neck canal cell with one nucleus (4) One neck canal cell with two nuclei

Q.65 Fern antherozoids or male gametes are –
(1) Biciliate with one tinsel and one whiplash flagella (2) Multiciliated reniform
(3) Multiciliated reniform (4) Multiciliated coiled

Q.66 In fern the haplophase is represented by –
(1) Prothallus (2) Sporophyte (3) Leaves (4) Vegetative body

Q.67 Sporophyte of *Pteridium* is –
(1) Dependent on gametophyte (2) Dependent on embryo
(3) Dependent on prothallus (4) Independent

Q.68 Distinct alternation of generation (Or) Two distinct and separate generation in a single life cycle occus in –
(1) Angiosperms/*Ficus* (2) Bryophytes/*Riccia* (3) Pteridophytes/*Pteris* (4) Gymnosperms/*Pinus*

Q.69 The first cell of a sporophytic and gametophytic phase in the life cycle of fern is –
(1) Oospore and gamete (2) Spore and oospore (3) Oospore and spore (4) Gamete and spore

Q.70 If the number of chromosome in the foot of a fern embryo is 8. What should be the number in its spore –
(1) 4 (2) 32 (3) 16 (4) 8

Q.71 White rust fungus is –
(1) *Rhizopus* (2) *Albugo* (3) *Pythium* (4) *Ustilago*

Q.72 Rhizoids of *Riccia* are –
(1) Unicellular smooth (2) Unicellular smooth and tuberculate
(3) Multicellular smooth and tuberculate (4) Multicellular tuberculate

Q.73 In *Ulothrix,* meiosis occurs in –
(1) Green cells (2) Zoospores (3) Zygote (4) Holdfast

Q.74 Moss peat is used as a packing material for sending flowers and live plants to distance places because –
(1) It serves as a disinfectant (2) It is easily available
(3) It is hygroscopic (4) It reduces transpiration

Q.75 Kidney shaped covering over *Dryopteris* sorus is –
(1) Ramentum (2) Placenta (3) Sporophyll (4) Indusium

Q.76 In *Funaria* capsule, dispersal of spores takes place through
(1) peristomial teeth (2) annulus (3) calyptra (4) operculum

Q.77 In *Funaria,* the stomata are found on
(1) foot (2) seta (3) capsule (4) All of these

Q.78. In *Cycas,* pollination occurs at ..... celled stage.
(1) One (2) two (3) three (4) four

ANSWERS KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ans	2	1	4	3	1	2	4	3	4	2	1	2	1	3	2	3	1
Que.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Ans	4	2	2	1	3	4	2	3	4	3	3	4	2	2	4	4	2
Que.	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Ans	1	3	3	3	2	2	4	1	2	1	2	2	1	4	2	4	2
Que.	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
Ans	2	3	1	1	2	3	3	3	3	1	4	2	4	4	1	4	3
Que.	69	70	71	72	73	74	75	76	77	78							
Ans	3	1	2	2	3	3	4	1	3	3							

03 Morphology of Flowering Plants

- Morphology deals with the study of forms and features of different plant organs like roots, stem, leaves, flowers, seeds, fruits etc.
- The plant body of typical angiospermic plant is differentiated into an underground root system and an aerial shoot system.
- The shoot system consists of stem (branches), Leaves and flowers. The roots, stems and leaves are vegetative parts of a plant and flowers constitute the reproductive parts.

MORPHOLOGY OF ROOT

ZONES OR PARTS OF A ROOT

A root consists of four zones or regions from the lower most part to the upper most part. These are :

(i) Root cap

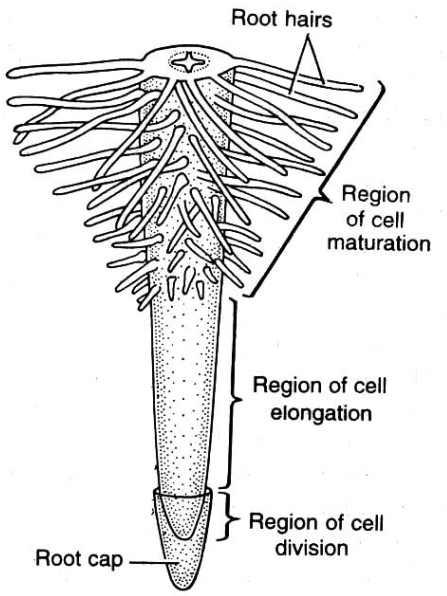
(ii) Meristematic region or main growing region

(iii) Zone of elongation

(iv) Maturation zone

(i) Root cap

- Root cap is present at the apex of root.
- It is made up of thin-walled cells. The main function of root cap is to protect the young growing cells of apical region.



Regions of Root cap.

- Generally a simple root cap is present besides some exceptions, e.g., in *Pandanus* (screw pine) multiple root cap is present while in aquatic plants, i.e., hydrophytes, the apical portion is protected by root pocket in place of root cap, e.g., (water hyacinth), *Eichhornia, Pistia, Lemna* etc.

(ii) Meristematic zone

- This zone is present just above the root cap. In this region cells divide actively hence it is the main growing region of the root.
- The cells are thin-walled lacking intercellular spaces.

(iii) Zone of elongation

- This zone consists of elongated cells.
- It increases the length of the root.
- In later stages, a large central vacuole filled with cell sap is present in each cell.
- Zone of elongation is few millimetres in length.

(iv) Maturation zone = Root hair zone

- This zone is characterised by the presence of unicellular root hairs formed by the epidermal cells.
- The cells of this region become rigid.
- This region is few centimetres long.

Types of roots

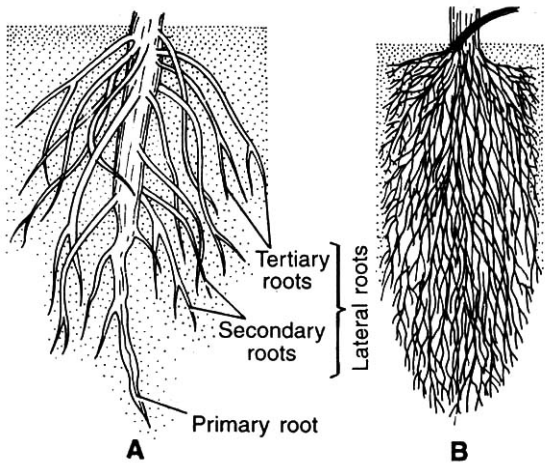
Roots are divided into two types :

(i) Tap roots

(ii) Adventitious roots

(i) Tap root

- Tap root or primary root develops from the radicle.
- It forms lateral branches or secondary roots which are further branched to form tertiary roots.
- Thus tap root along with its branches, i.e., secondary and tertiary roots form tap root system.
- It is generally found in dicotyledons.



Root types A. Tap root B. Fibrous or adventitious root.

(ii) Adventitious roots

- These roots develop from any part of the plant instead of radicle.
- Adventitious roots can be grouped into three types on the basis of their appearance :
  - (a) Roots arising from the base of the stem, e.g., maize, wheat, rice, onion, etc.
  - (b) Roots arising from the leaf, e.g., *Bryophyllum, Podostemon,* etc.
  - (c) Roots developing from the nodes and internodes of the stem, e.g., *Ficus* (banyan), *Pothos* (money plant), etc.

MODIFICATIONS OF ROOTS

In order to carry-out some special functions, i.e., assimilation, storage, etc., the roots are modified into different forms. This modification takes place both in tap roots as well as in adventitious roots.

1. Modification of tap root

(i) Fusiform = Spindle shaped

- In these roots the middle portion becomes thicker and tapers on both the ends, e.g., *Raphanus sativus* (radish) Fig. A.

(ii) Conical

- These roots have broad base tapering towards the apex, e.g., *Daucas carota* (carrot). Conical roots perform the Fig. B.

(iii) Napiform

- The upper portion of these fleshy roots is inflated or swollen which tapers towards the lower end, e.g., *Brassica rapa* (turnip hypocotyl is edible) *Chenopodium album, Beta vulgaris* (Beet root) Fig. C.

(iv) Tuberous

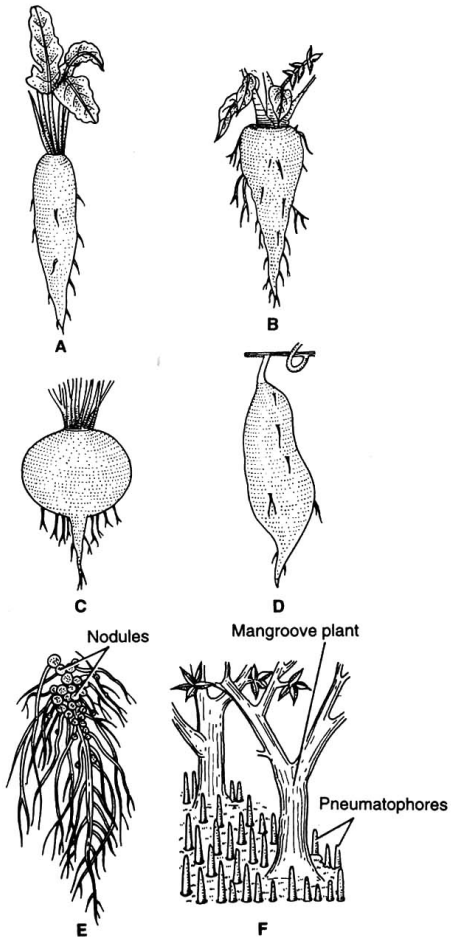
- Because of the irregular shape of the root, the food is stored in any portion, e.g., *Mirabilis jalapa* (4O'clock plant) Fig. D.

(v) Nodulated

- The plants of the Leguminosae family are characterised by the presence of nodules on branches of roots in which nitrogen fixing bacteria are present, e.g., *Cicer arietinum* (gram), *Arachis hypogea* (peanut), *Pisum sativum* etc. Fig. E.

(vi) Pneumatophores or Respiratory roots

- In mangrove plants, i.e., plants growing in saline marshes, the branches of tap root grow vertically upwards showing **negative geotropism**. **These roots are called pneumatophores**, which have minute pores on their exposed portion called pneumathodes to take O_2, e.g. *Rhizophora, Avicenia, Heritiera, Sonneratia* etc., Mangrove plants are found in the sunderbans of West Bengal Fig. F.



Tap root modifications A. Fusiform B. Conical C. Napiform D. Tuberous E. Nodulated F. Pneumatophores.

2. Modification of adventitious roots

(i) Tuberous roots

- These roots become fleshy because of storing food and have no definite shape, e.g., *Ipomoea batatus* (sweet potato) Fig. A.

(ii) Fasciculated roots

- From the base or lower nodes of stem these tuberous roots arise in groups, e.g., *Dahlia, Asparagus, Ruellia*, etc. Fig. B.

(iii) Nodulose roots

- The apex of these roots become swollen because of the accumulation of food, e.g., *Maranta, Curcuma amanda,* etc. Fig. C.

(iv) Moniliform roots

- These are also called beaded roots because of their bead like appearance. Such roots are swollen at various places, e.g., *Momordica* (bitter gourd), *Portulaca* (rose moss), *Cyperus, Vitis,* etc. Fig. D.

(v) Annulated roots

- In these roots swelling occurs at various places because of which the shape of roots look like the closely placed rings, kept one above the other, e.g., *Psychortia, Cephaelis,* etc. Fig. E.

(vi) Prop roots

- In some plants roots arise from branches and enter the soil. Thus they provide mechanical support to densely branched, huge trees, e.g., *Ficus bengalensis* (banyan), *Ficus elastica* (Indian rubber), etc. Fig. F.

(vii) Stilt roots or Brace roots

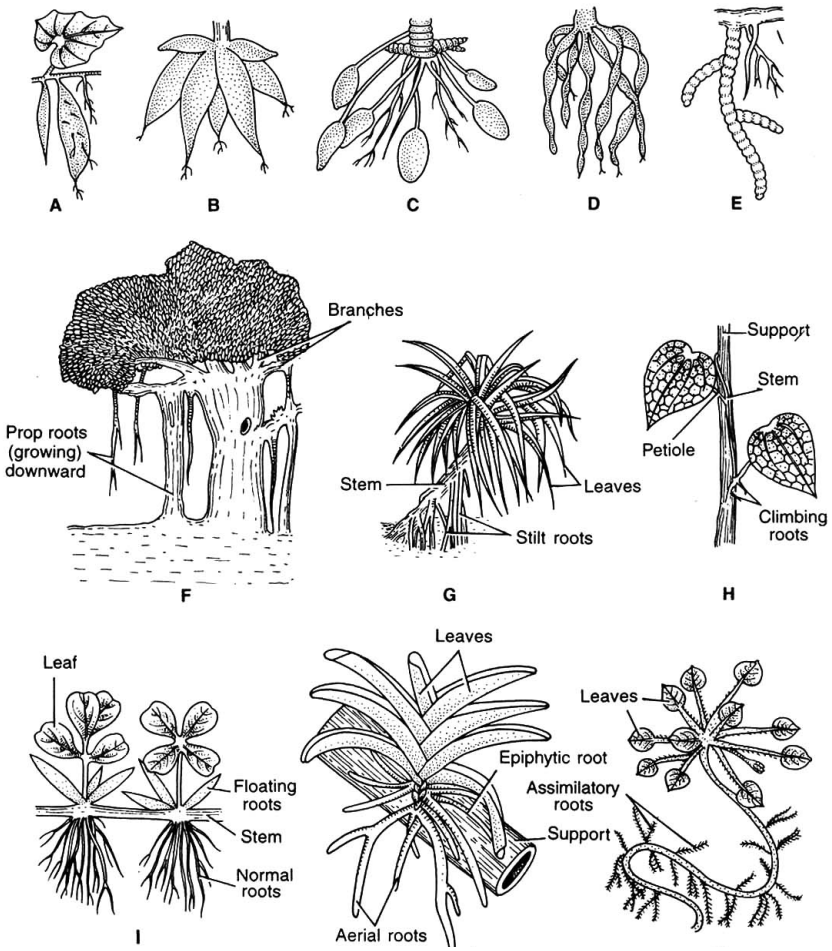
- In some plants roots are formed from the nodes of lowermost portion of the stem and provide mechanical support to the plant by fixing it in soil firmly, e.g., *Pandanus tinctorius* (screw pine), *Zea mays* (maize), *Saccharum officinarum* (sugar cane), etc. Fig. G.

(viii) Climbing roots

- In some climbers roots are formed from the nodes of stem which help the plant to climb, e.g., *Pothos* (money plant), *Piper betle* (pan), etc. Fig. H.

(ix) Floating roots

- In some aquatic plants, e.g., *Jusiaea,* two types of roots are formed from the nodes of the stem. One remains inside the water while other remain in air helping the plants in floating Fig. I.



Adventitious roots modifications A. Tuberous root B. Fasciculated root C. Nodulose root D. Moniliform root E. Anulated root F. Prop roots G. Stilt roots H. Climbing roots I. Floating roots J. Epiphytic roots K. Assimilalory roots.

(x) Epiphytic roots

- Some epiphytes, e.g., (orchids) have aerial roots. In these roots the outer covering is made up of spongy tissue, the velamen which absorbs moisture from air Fig. J.

(xi) Assimilatory roots

- In some plants the roots start manufacturing food after developing chlorophyll, e.g., *Tinospora, Trapa,* etc. Fig. K.

(xii) Parasitic roots

- Some parasitic plants develop sucking roots or haustoria which enter the host plant fulfilling the purpose of nutrition, e.g., *Cuscuta* (Dodder), etc.

(xiii) Mycorrhizal roots

- In some plants the roots bear fungal hyphae which function as root hair, e.g., *Pinus.*

(xiv) Clinging roots

- These roots arise from the nodes of stem and penetrate the stem of host plant, e.g., Orchids, etc.

(xv) Reproductive roots

- In some plants, e.g., *Trichosanthes dioica* (parwal), vegetative buds are formed by roots which form new plants.

(xvi) Root thorns

- Roots of some plants arise from the stem and change into thorns, thus performing the protective function, e.g, *Pothos* (money plant), *Acanthorhiza*.

(xvii) Contractile roots

- In some plants the apical portion of some thick roots of the underground stem contract and help the plant fixing in soil, e.g., *Crocus, Allium cepa* (onion).

Function of roots

(i) Fixation

(ii) Absorption of water and minerals

(iii) Storage of food

(iv) Conduction of water

(v) Photosynthesis and respiration

MORPHOLOGY OF STEM

CHARACTERISTICS

- Stem is the aerial part of the plant which develops from plumule.
- It is positively phototropic and negatively geotropic.
- Stem along with its leaves and branches forms the shoot system.
- Stem is the ascending portion of the plant having nodes and internodes. Leaves and branches are formed on the nodes of the stem.
- In stem, branches are exogenous in origin. The hairs or trichomes found on the stem are multicellular.

MODIFICATIONS OF STEM

There are three different type of functions that these modified stems perform (a) Perennation (b) Vegetative reproduction (c) Storage of food.

Modified stem can be classified into three categories as follows :

1. Underground modifications **2. Subaerial modifications** **3. Aerial modifications**

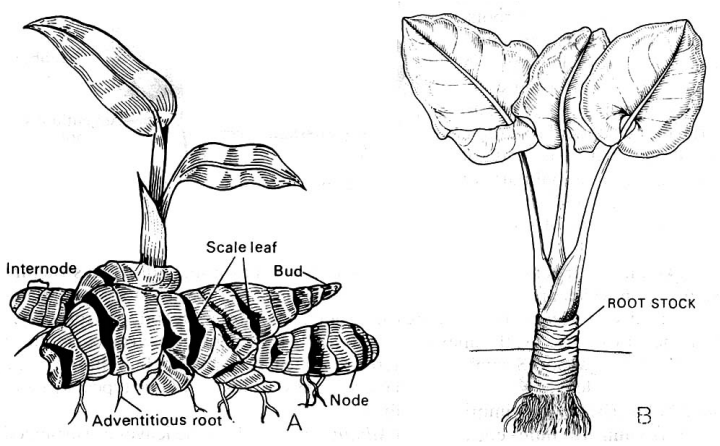
1. UNDERGROUND MODIFICATIONS

Such stems are found under the surface of soil and store food materials due to which they become quite thick and fleshy. They are usually brownish, whitish or yellowish. Although they are not green but can be easily differentiated from roots.

Different types of Underground modified stems

(i) Rhizome

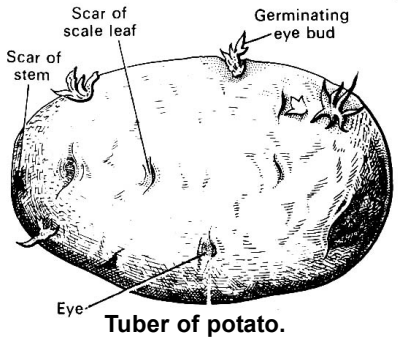
- This type of stem is thick, fleshy and usually horizontal. Nodes and internodes are clearly visible in such stems. Nodes bear brown scale leaves which are thin and sessile. In the axil of these scale leaves are born buds, which become aerial. Adventitious roots arise from the lower surface of nodes. At the end of each growing season the aerial branches dry and die. Rhizomes are mostly horizontal or straggling e.g., Ginger, Turmeric, Lotus, Banana, Ferns etc.



A. Rhizome of ginger. B. Root stock (Vertical rhizome) of *Alocasia.*

(ii) Tuber

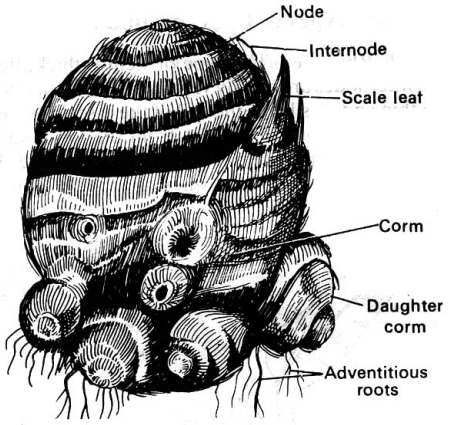
- Tuber is the swollen end of a branch developed underground. In such cases axillary branches develop underground after growing horizontally for some time and swell up at the end. These swollen portions of stem have some depressions at nodes which bear scale leaves. In the axil of these scale leaves are present some buds which give rise to aerial branches. There are no adventitious roots on the tubers. The tubers are almost spherical to slightly elongated and store reserve food e.g., Potato, *Jerusalem artichoke,* (*Helianthus tuberosus*).



Tuber of potato.

(iii) Corm

- This is a small underground stem with stored food, which is with more diameter than length. It grows in the vertical direction under the soil surface. Some horizontal circular lines are very clearly seen in corm, these are nodes with large number of scale leaves. From the base of nodes arise adventitious roots. Scale leaves bear axillary buds, which give rise to new corm. A terminal bud is always present in a corm which gives rise to aerial branch under favourable conditions. At the end of growing season aerial parts of the plant dry and die e.g., *Colocasia, Crocus, Amorphophallus, Gladiolus, Colchicum*.

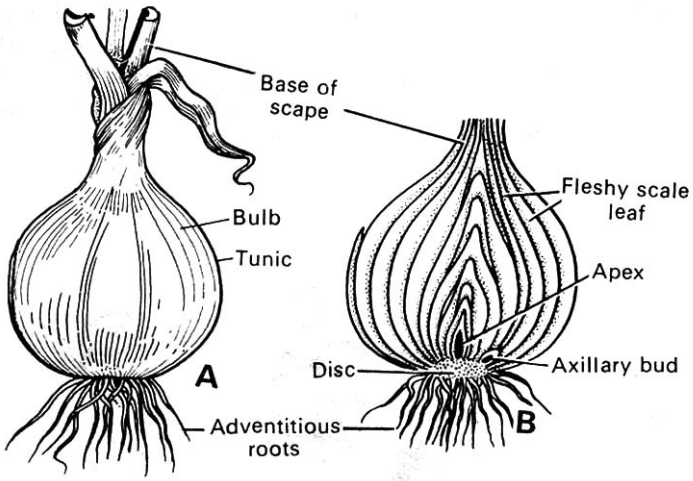


Corm of *Colocasia.*

(iv) Bulb

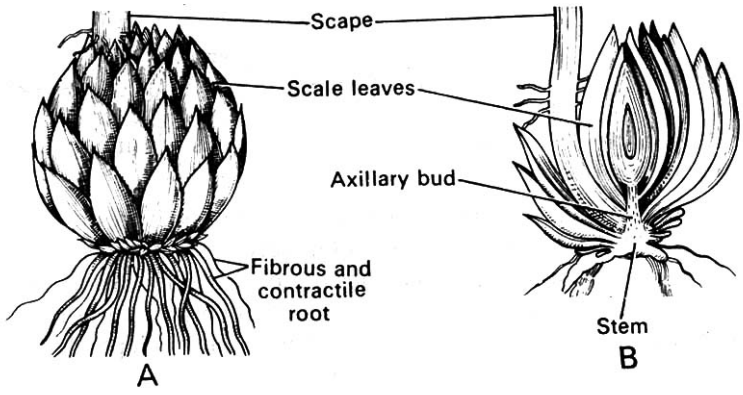
- It is highly reduced stem represented by a small disc like structure (stem) upon which are borne numerous fleshy scale leaves (which store food material). This disc and leaves together are called bulb. Numerous adventitious roots arise from the base of disc. At the apex of disc is borne an apical bud which gives rise to an aerial flowering shoot (Scape). Also there are some lateral axillary buds borne in the axil of the scale leaves which may form more scapes. Bulbs are of two types (a) Tunicated bulbs. (b) Scaly or imbricate bulb.

a. **Tunicated bulbs** e.g., Onion (*Allium cepa*) **:** The scale leaves are arranged in a concentric fashion as seen in a cross section. The whole bulb is covered with some dry membranous scale leaves which form the tunic.



Tunicated bulb of Onion B. L.S. of bulb.

b. **Scaly or imbricated bulb :** The scale leaves are not concentric but are arranged loosely like the petals of a flower, such a bulb is not a compact body and is not covered with any common tunic e.g., garlic (*Allium sativum*) and Lilies (*Lilium species*). In garlic a number of cylindrical but separate (i.e., not concentric) fleshy scales, called cloves are arranged as in a naked bulb but a group of such cloves are enclosed in a whitish, skinny tunic.



A. Scaly bulb of garlic. B. L.S. of bulb

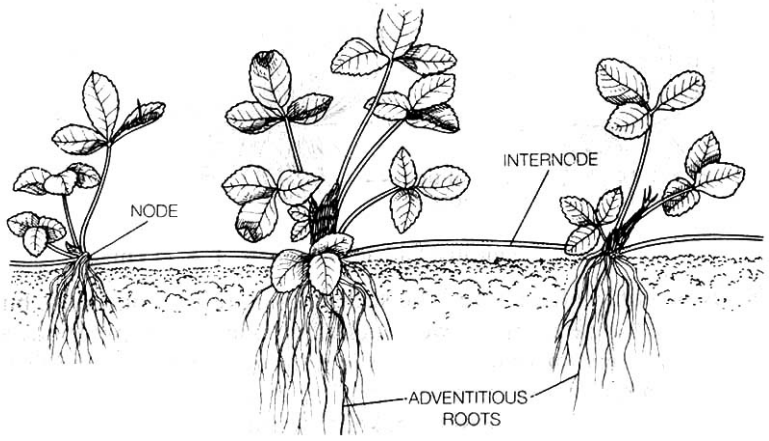
2. SUB AERIAL MODIFICATIONS

In subaerial modifications some part of the stem lives underground whereas remaining part of stem is aerial. Dormant buds found at the stem become active and develop lateral branches for vegetative reproduction. Thus vegetative propagation is very fast in these plants. Subaerial modified stem may be of the following types :

(i) Runner

- It is elongated, prostrate, aerial branch with long internodes and roots at nodes.

- Such plants have long and thin internodes and branches creep over the surface of soil. Such branches develop adventitious roots at nodes on lower side. Scaly leaves are present on nodes, from the axil of which arise aerial branches. When long branches break up by any method they form new plants. In this way large number of new plants are formed e.g., Doob grass, *Oxalis, Hydrocotyle*.

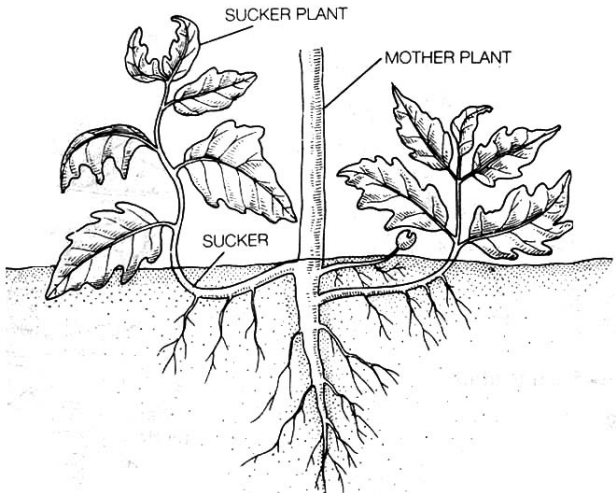


A runner.

- Sometimes **sobole** term is used when the internodes of runners are thick and sometimes included in rhizome e.g., *Agropyron*.

(ii) Sucker

- It arises by axillary bud of underground part of stem. The branch creeps below the surface and grows obliquely upward and produce new shoot.
- This stem also arises from the axillary branch arising from the node of underground stem. Such a branch moves obliquely or sometimes grows horizontally under the surface of soil and then comes out of the soil growing obliquely upwards. Adventitious roots arise from the nodes of underground portion of stem. Branches break up from the parent plant thus forming new independent plant e.g., *Chrysanthemum,* Rosa, Mint.



A sucker of *Chrysanthemum.*

(iii) Offset

- Short horizontal branch producing a cluster of leaves above, the cluster of roots bear e.g., *Pistia, Eichhornia*.

(iv) Stolon

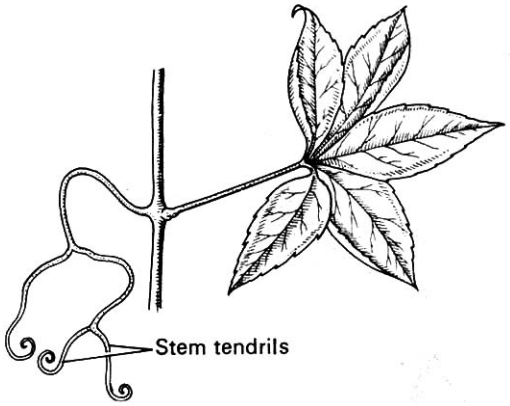
- It is subterranean long lateral branch arising from base of the stem, e.g., *Colocasia* first grows obliquely upward and then bends down to touch the ground surface.

3. AERIAL MODIFICATIONS

Such modifications are aerial. The real stem gets so much modified that it is difficult to identify it as a stem. These are of the following types :

(i) Stem tendril

- In some weak plants, with weak stem axillary or terminal buds are modified into tendril for climbing. Such tendrils have nodes and internodes and nodes have scale leaves bearing buds in their axil which develop into flowers. At the point of origin, such tendrils are thick but become thin and branched at the apex e.g., *Vitis* (modified apical bud) *Passiflora* (modified axillary bud).



Stem tendril.

Tendril of cucurbita.

- The nature of some tendrils is not clear in some plants e.g., Cucurbits. It is considered that the lower portion of tendril is modified stem while the upper part is modified leaf.

FUNCTIONS OF STEM

Primary or Main Functions

- It bears and supports leaves, flowers and fruits.
- The various appendages borne on the stem are placed in such a fashion that they are able to carry out their functions most effectively.
- It conducts water and mineral salts from roots to the leaves and fruits.
- The food manufactured in the leaves is transported to the roots, fruits and organs of storage through the stem.
- Every year it adds new cells, tissues and organs which are required for the continued functioning of the plants.

MORPHOLOGY OF LEAF

CHARACTERISTIC

- It is dissimilar lateral outgrowth of the stem.
- The leaf is exogenous in origin.
- It is borne on the stem in the region of a node.
- An axillary bud is often present in the axil of the leaf.
- Leaf has limited growth.
- An apical bud or a regular growing point is absent.
- The leaf base may possess two lateral outgrowths called stipules.
- A leaf is differentiated into three parts – leaf base, petiole and lamina.
- The lamina possesses prominent vascular strands called veins.
- It is green and specialised to perform photosynthesis.
- Leaf bears abundant stomata for exchange of gases.
- It is the major seat of transpiration.

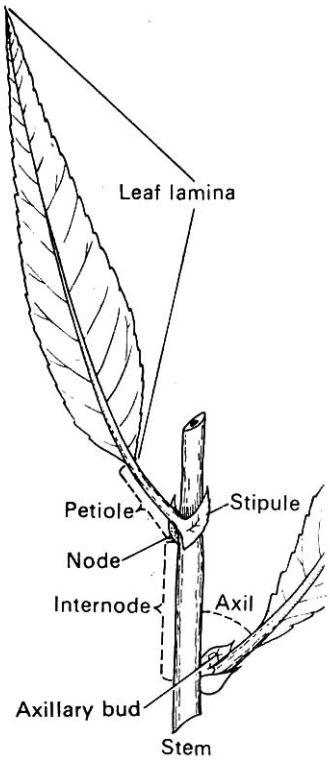
PARTS OF A TYPICAL FOLIAGE LEAF

A typical foliage leaf has three main parts :–

1. Leaf base **2. Petiole** **3. Lamina**

1. Leaf base

- The part of leaf attached to the stem or branch is known as leaf base. Usually it is broader to get sufficient base for attachment. Different plants have different types of leaf bases which are as given below :–



Parts of a typical leaf.

(i) Pulvinus

- Most of the leaves have a swollen leaf base known as pulvinus. Its attachment on the stem is not strong. So leaves with such leaf bases can be plucked easily e.g., mango, beans, banyan tree, gulmohar, gram, pea, *Tamarindus* and *Mimosa pudica* plant.

(ii) Sheathing

- In monocot stem leaf base becomes broad and flat and covers a part of the node of stem. *Zea mays,* sugarcane, banana etc. In banana, sheathings of many leaves jointly make a stem like structure known as false stem. True stem in banana is the underground stem.

(iii) Decurrent

- In some plants petiole and leaf base, both become broad, flat and winged. These ensheath the upper part of node e.g., *Symphytum, Laggera, Crotolaria* etc.

(iv) Amplexicaul

- When sheathing leaf base clasps and surround the stem completely e.g., *Polygonum*.

Stipules

- Leaves of some plants have lateral appendages on each side of leaf base, known as stipules. The leaves without stipules are known as exstipulate. Stipules are usually green, but sometimes appear withered also. Main function of these structures is to protect the leaf in the bud. When green these synthesize food also.

VENATION

In different leaves, veins are variously arranged. This arrangement of veins in leaves is known as venation. Venation is of two types. Reticulate and parallel.

1. RETICULATE VENATION

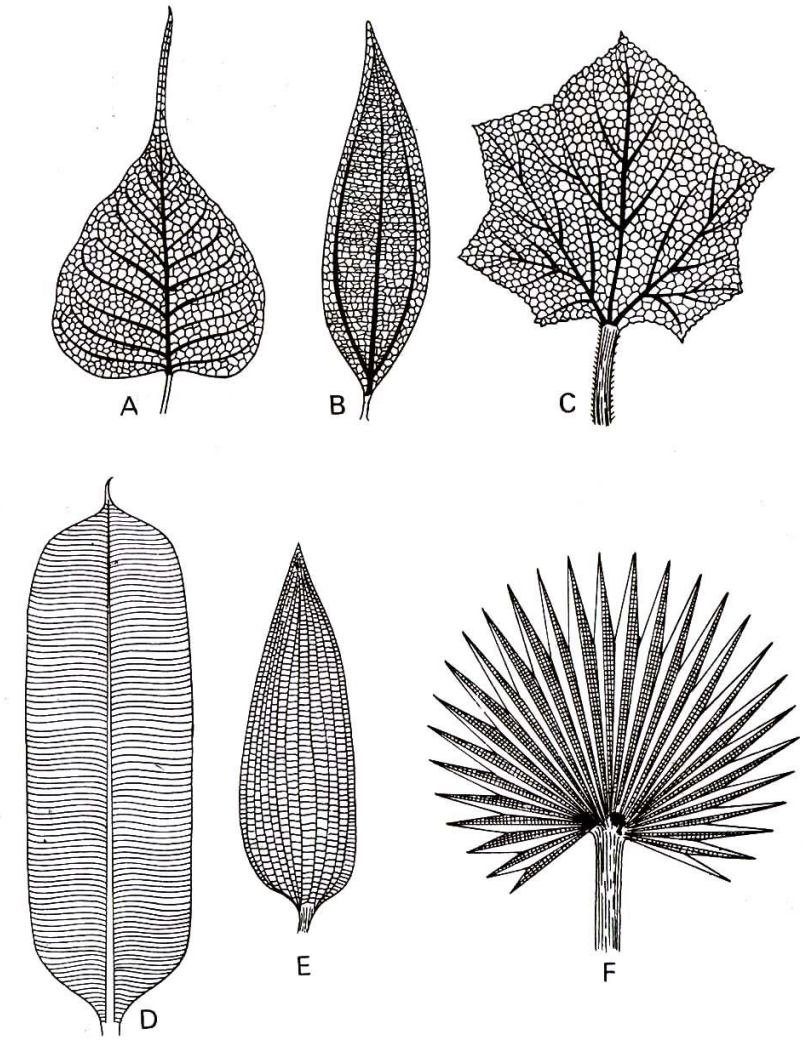
- In this type, main veins divide into various branches and make a net-like structure in the lamina. It is found in most of the dicot leaves. Exceptionally it is also present in monocot leaves e.g., *Smilax* and *Dioscorea*. On the basis of number of mid veins, it is of two types :

(i) Pinnate or unicostate

- In this type of venation there is one midrib or costa in the centre of lamina. It gives out branches on lateral sides like the wings of a bird. Small branches or veinlets again come out from these in every direction and make a network e.g., Mango, peepal.

(ii) Palmate or multicostate

- In this type, many midribs like the fingers of a hand, arise from the top of petiole and spread on the upper side. It has two kinds :–



Venation in leaves
A. Reticulate unicostate (Pinnate), B. Multicostate (Palmate) convergent, C. Multicostate (Palmate) divergent, D. Parallel pinnate (unicostate), E. Parallel palmate (Convergent), F. Parallel palmate (Divergent).

2. PARALLEL OR STRIATE VENATION

- In this type, all veins run parallel to each other. Most of the monocot leaves have this type of venation. Rarely it is present in dicot leaves e.g., *Calophyllum, Eryngium* etc. On the basis of number of midribs it is of two types :–

(i) Pinnate or unicostate

- In this type, lamina has a mid rib in the centre. Lateral veins come out perpendicular to the mid rib, which run parallel to each other towards the margin or apex of lamina e.g., Banana, Ginger, *Canna* etc.

(ii) Palmate or multicostate

- In this type, many mid veins come out from the petiole. It is of two types :–

SIMPLE AND COMPOUND LEAVES

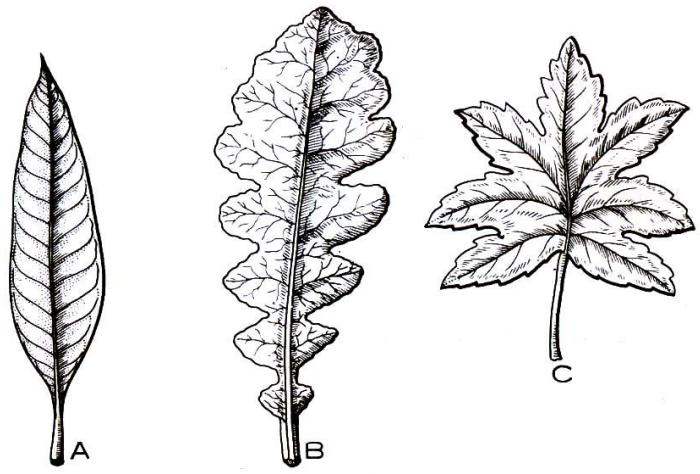
On the basis of incision of Lamina, leaves may be of two types : Simple and compound.

1. SIMPLE LEAF

- In this type, there is a single lamina which is usually entire e.g., Mango, Guava, *Cucurbita,* Cucumber etc. Sometimes it is incised but incision never reaches upto the mid vein.

(i) When the direction of incision is towards the mid rib, the leaf is known as pinnate simple leaf. e.g., *Raphanus sativus*.

(ii) When the direction of incision is towards the petiole, leaf is known as palmate simple leaf e.g., *Ricinus*.



A. B. C. Simple leaves.

2. COMPOUND LEAF

- In this type, incision of lamina reaches upto the midrib or petiole due to which lamina is divided into several small parts known as leaflets. On the basis of incision compound leaves are of two types :–

(i) Pinnate compound leaf

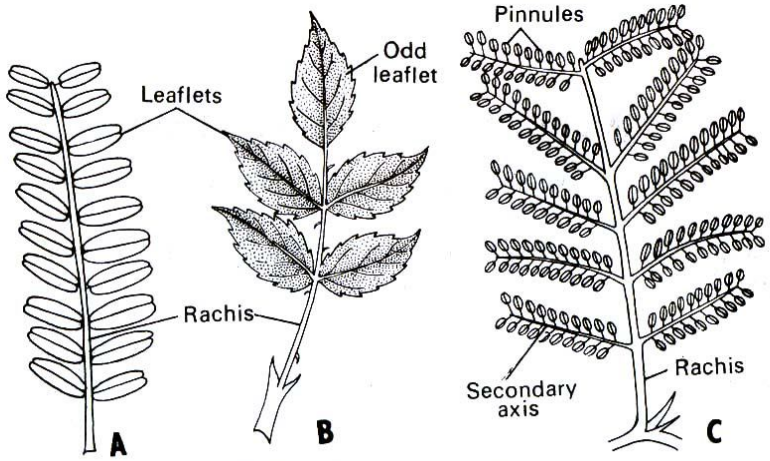
- In this type of compound leaf, incision of lamina is directed towards the mid rib which is known as rachis. Leaflets are arranged on both side on the rachis or on its branches. On the basis of division of rachis these are of four kinds :–

a. Unipinnate

- In this type, leaflets are directly attached on the rachis. If number of leaflets is even, the leaf is known as Paripinnate e.g., *Tamarindus*.
- If number of leaflets is odd, leaf is known as imparipinnate e.g., rose, neem.

b. Bipinnate

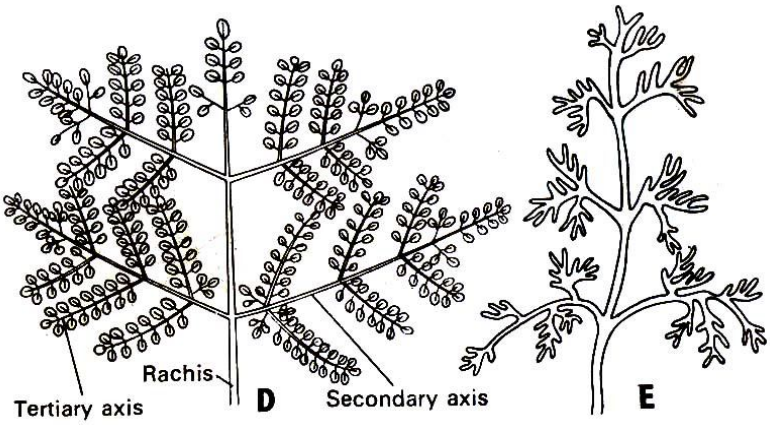
- In this type rachis divides and gives rise to secondary axis on both sides on which leaflets are arranged e.g., *Acacia, Mimosa pudica, Delonix* etc.



Pinnate compound leaves : A. Unipinnate paripinnate compound leaf,
B. Unipinnate imparipinnate compound leaf, C. Bipinnate compound leaf.

c. Tripinnate

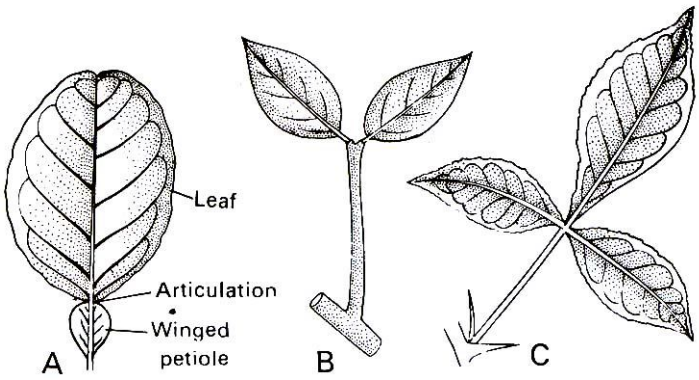
- In this type secondary axis too, divides and gives rise to tertiary axis on which leaflets are attached e.g., *Moringa, Oroxylon, Melia, Azadirachta*.



D. Tripinnate compound leaf, E. Decompound leaf.

(ii) Palmate compound leaf

- In these leaves incision of leaf is directed towards the petiole due to which all leaflets seem to be articulated on the upper end of petiole. It does not have any rachis. On the basis of leaflets these are of five types.

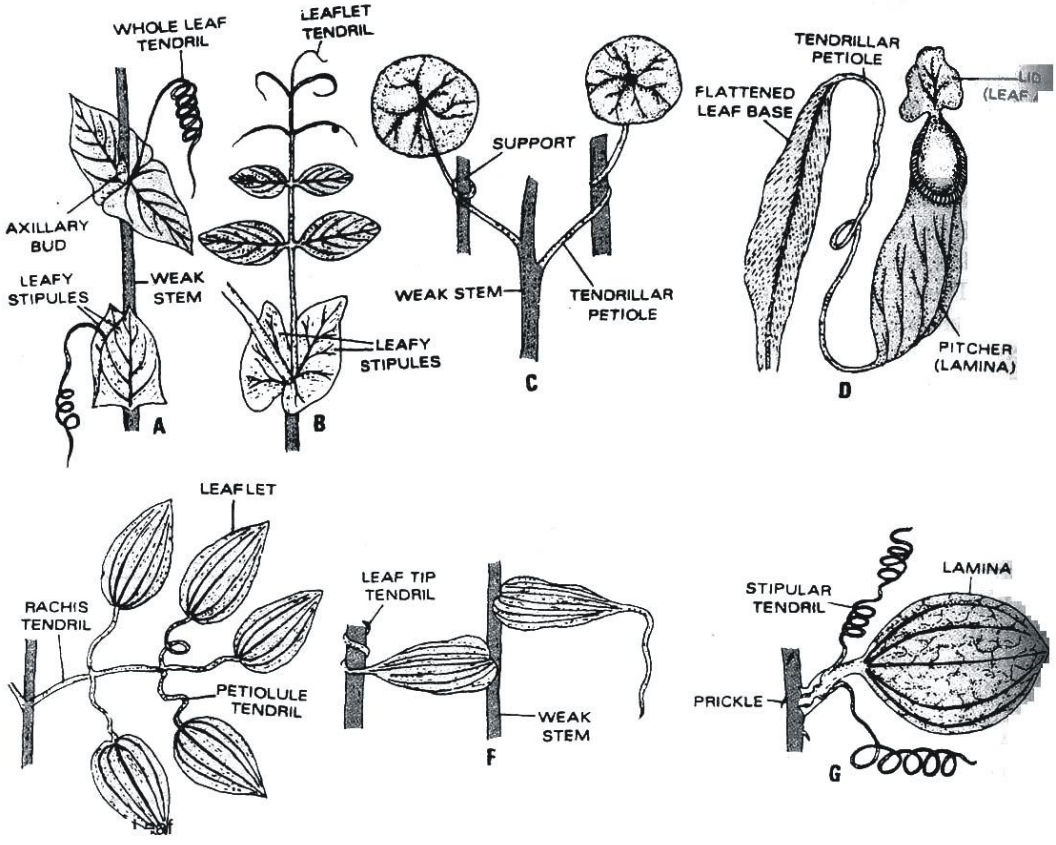


Palmate compound leaves
A. Unifoliate compound leaf, B. Bifoliate compound leaf, C. Trifoliate compound leaf.

MODIFICATIONS OF LEAVES

1. LEAF TENDRILS

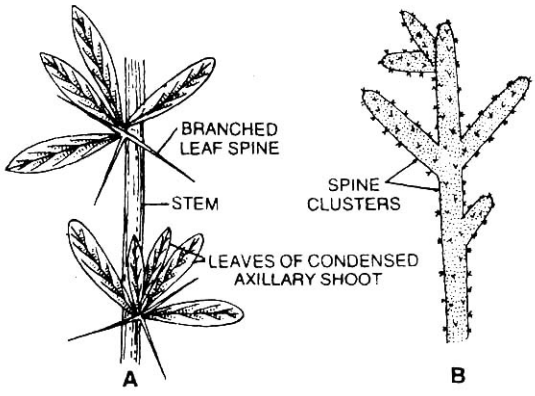
- Tendrils are thread-like sensitive structures which can coil around a support to help the plant in climbing. Leaf tendrils are usually unbranched and devoid of scales.



Leaf Tendrils. A. Whole leaf tendrils of *Lathyrus aphaca* (Jungli Mattar). B. Leaflet tendrils of *Pisum sativum* (Edible Pea or Mattar). C. Petiolar tendrils of Garden Nasturtium. D. Petiolar tendril of *Nepenthes*. E. Rachis and petiolule tendrils of *Clematis*. F. Leaf tip tendrils of *Gloriosa*. G. Stipular tendrils of "*Smilax*.

2. LEAF SPINES

- The leaf parts become changed into spines in order to protect the plant from grazing animals and excessive transpiraton. Prickles occur at various positions (margins, apex, surface) on the leaves for the same prupose, e.g., *Aloe, Solanum surattense* (=*S. xanthocarpum*), *Carthamus oxycantha*.
- In Barberry, the leaves of the main stem are modified into branched 3–5 rayed spines. Dwarf branches arise in their axils. The spines present on the areoles of *Opuntia* also represent the leaves. Leaf spines also occur in other cacti and the climbing varieting of *Asparagus.* Spines of *Zizyphus* and *Acacia* are modified stipules.



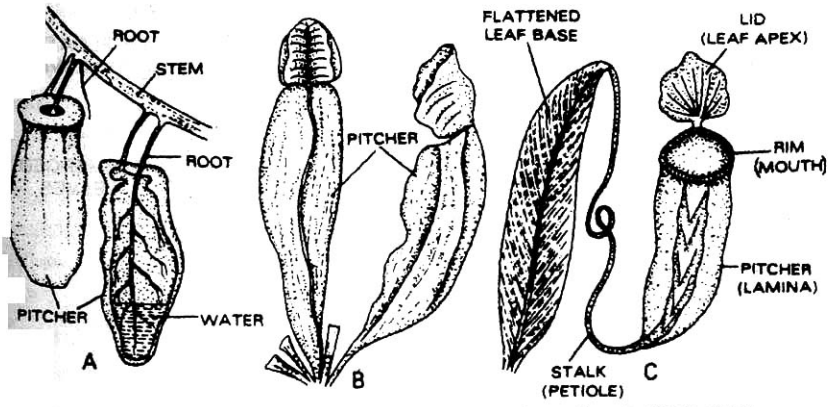
Leaf spines. A. Barberry, B. Cactus.

3. PHYLLODES (PHYLLODIA)

- In several species of *Acacia* found in the deserts of Australia (e.g., *A. longifolia, A. glaucescens, A. recurva, A. auriculiformis*), the bipinnate lamina is absent. Instead petiole and part of the rachis become flattened into sickle-shaped structure for performing the function of food synthesis. Such a flattened petiole which carries out the functions of the lamina is called phyllode. Formation of phyllode is a mechanism to reduce transpiration because (i) it is vertically placed and (ii) has fewer stomata.
- In *Parkinsonia aculeata,* the rachis ends in a spine. Rachis branches (=secondary raches) are elongated, flattened and green to function as phyllodes. They bear small leaflets which fall off very early.

4. LEAF PITCHERS

- The leaf or lamina is modified to form a large pitcher in *Dischidia* (fig. A)*, Sarracenia* (fig. B) and *Nepenthes* (fig. C) and . In epiphytic *Dischidia* the whole leaf is changed into an open pitcher for storing rain water. The same is absorbed throughout the year by adventitious roots (=nest roots). In *Nepenthes* and *Sarracenia* the pitchers are meant for catching and digesting insects. The lamina is modified into pitcher. The leaf apex gives rise to a coloured lid for attracting the insects.



Leaf Pitchers. A. Leaf pitcher of *Dischidia,* one in section to show stored water and absorbing root, B. Leaf pitcher of *Sarracenia,* C. Leaf pitcher of *Nepenthes*.

- In *Nepenthes* the leaf base is foliaceous while the leaf stalk is tendrillar. The rim of the pitcher has nectariferous glands. The interior of the pitcher is slippery. The base is filled up with a digestive fluid.

5. SUCCULENT LEAVES

- The leaves are fleshy or swollen. They store water, mucilage or food materials. Succulent leaves occur in plants of saline and xerophytic habitats, e.g., *Aloe, Agave, Bryophyllum, Portulaca*.

INFLORESCENCE

- The arrangement of floweres and mode of distribution of flowers on the shoot system of a plant is called inflorescence.

KINDS OF INFLORESCENCE

- The inflorescence has been classified into four distinct types accoding to the modes of branching and modification of the peduncle. These kinds are :–

1. **Racemose (= Indefinite)**
2. **Cymose (= Definite)**
3. **Special**

1. RACEMOSE

- The peduncle continues to grow forming new bracts and flowers in succession. Consequently large number of flowers are produced, the oldest being near the base and the youngest near the growing point (in acropetal succession). Principal types of racemose inflorescence are as follows :–

(i) Main Axis Elongated

a. Raceme

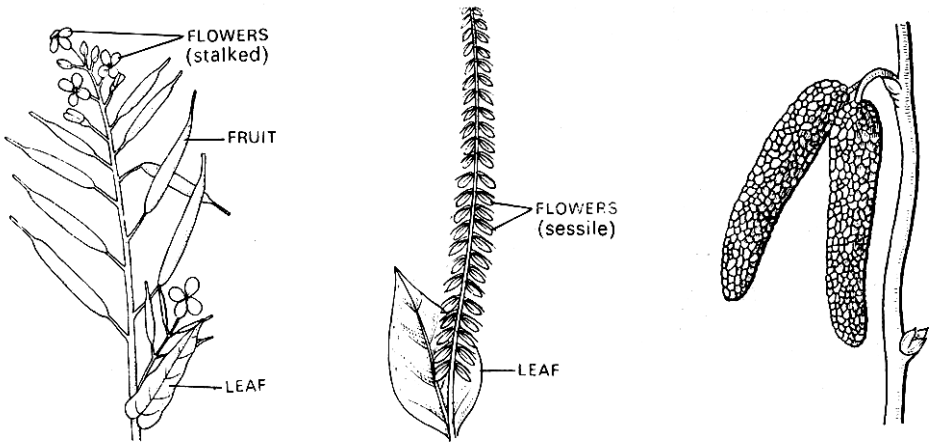
- Peduncle is elongated and flowers are pedicellate e.g., Larkspur, Mustard, Radish.

b. Spike

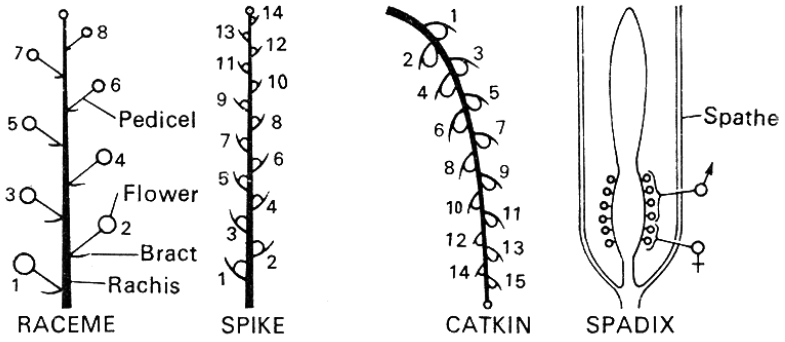
- Central axis is elongated but flowers are sessile e.g., *Achyranthes, Adhathoda.*

c. Catkin

- Pendulous spike which bears naked pistillate or staminate flowers (but not both) e.g., Mulberry, Morus, Birch, Oak.



A Raceme of mustard, B. Spike of *Achyranthes aspara*, C. Catkin of mulberry.

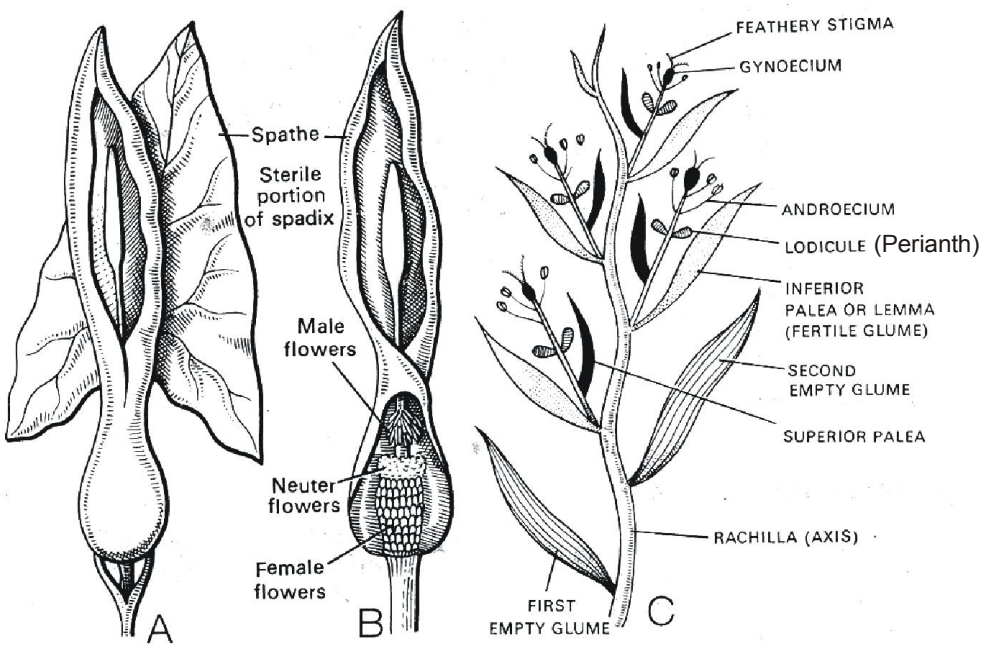


d. Spadix

- Spike with fleshy axis and having both male and female flowers. It is surrounded by a large bract (usually coloured brightly) called spathe e.g., *Musa,* Palm, *Colocasia, Alocasia*.

e. Spikelet

- A very small spike with one or a few flowers (florests). Spikelet are arranged in spike, raceme or panicle. Each spikelet bears at its base two minute bracts called empty glumes, slightly higher up, it bears a third bract called flowering glume or fertile glume or lemma or lower palea. Opposite to the lemma it bears a small glume called upper palea. Each flower of the spikelet remains enclosed by a lemma or palea e.g., Family–Gramineae (wheat, rice, bamboo), Poaceae (Grasses).



A. and B. Spadix of *Colocasia antiquorum,* C. Spikelets of wheat.

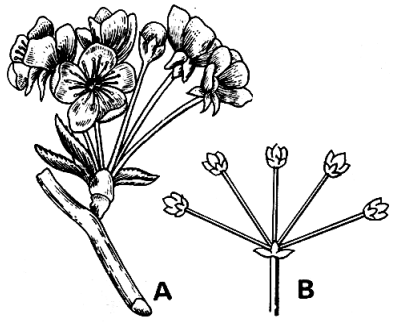
(ii) Main Axis Shortened

a. Corymb

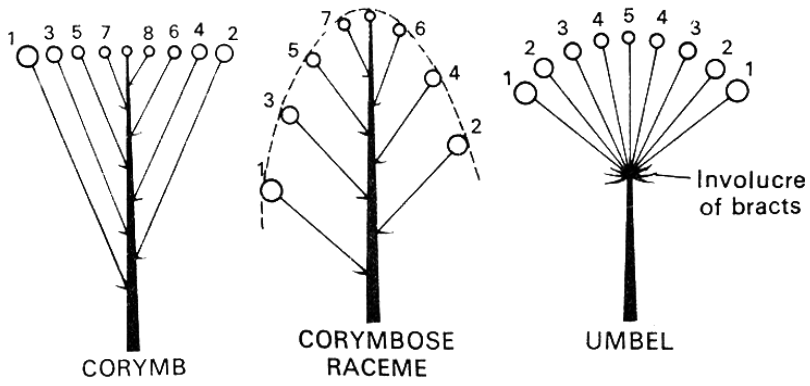
- The main axis is comparatively short, and the lower flowers have much longer pedicels than the upper ones so that all the flowers are brought more or less to the same level. e.g., Candytuft (*Iberis*), *Capsella*.

b. Umbel

- The main axis is very much shortened and all flowers appear to be arising from the same point. The younger flowers are in the center and older ones towards the periphery. The flowers are usually bracteate. Thus the bracts form a whorl or a cluster at the base of flowers. This group of bracts is called involucre e.g., *Hydrocotyle, Centella* (Indians pennywort), *Prunus,* Onion.



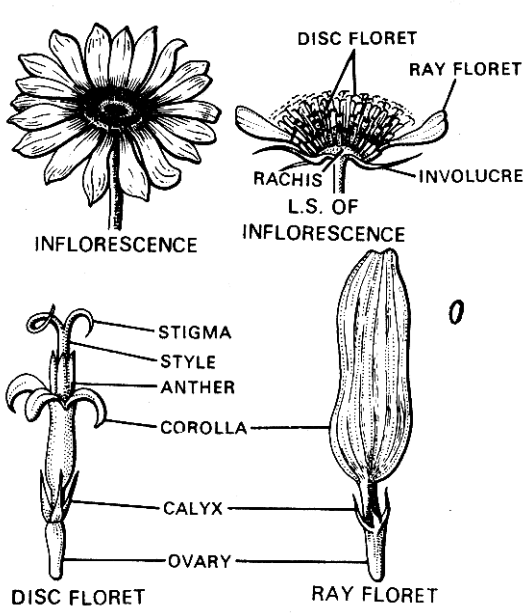
A. Umbel of *Prunus cerasus* (young), B. Outline plan.



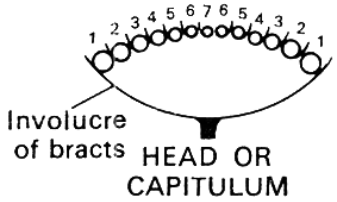
(iii) Main Axis Flattened

a. Capitulum (= Head)

- The receptacle is flattened and bears numerous sessile and small florets in a centripetal manner i.e., youngest in the center and older towards the periphery. Individual florets are bracteate. Also the whole cluster of florets is surrounded by a whorl of bracts collectively called involucre. Two kinds of florets can be recognized on the receptacle.



Capitulum of sunflower with disc and ray florets.



(i) Ray florets

- Arranged on the rim of receptacle having distinct yellow and strapshaped petals. These florets are female or sterile and are always zygomorphic. They may be arranged in one or more whorls.

(ii) Disc florets

- Grouped in the center and are bisexual and actinomorphic e.g., Sunflower, *Zinnia*, *Cosmos* (Asteraceae).

2. CYMOSE (DEFINITE)

- In cymose inflorescence the apical meristem of peduncle produces the first flower (e.g., terminating in a flower which does not elongate further). Other flowers which arise later and are younger are borne on lateral branches from the axis below. In a cymose inflorescence oldest flower remains in the center and youngest towards the periphery. This arrangement is called centrifugal. The cymose inflorescence are of the following types :

(i) Uniparous-Monochasial cyme

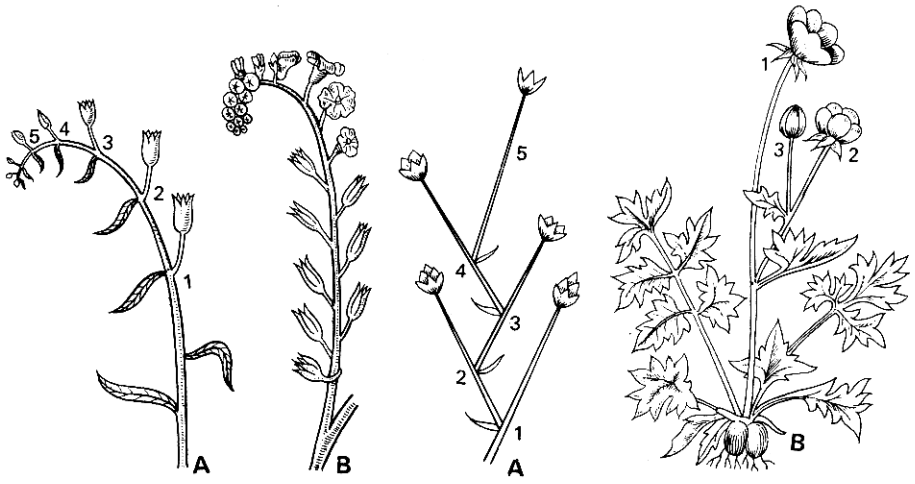
- A single lateral branch arises from the peduncle of old flower which terminates in a flower. The later branch also terminates in a flower. Monochasial cyme can be of two types :–

a. Helicoid cyme or Bostryx

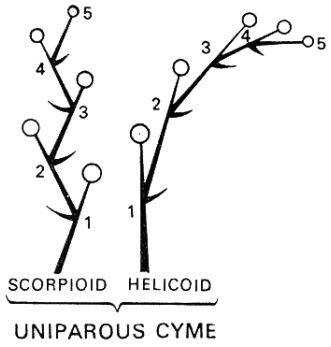
- The main peduncle ends in a flower. It gives of a lateral branch on one side which again ends in a flower. This branch gives rise to another lateral branch on the same side i.e., all the lateral branches arises either on left side or right side. e.g., *Heliotropium, Drosera, Atropa, Datura, Begonia, Solanum* (Solanaceae).

b. Scorpoid cyme or Cincinnus

- In this case the lateral branches arises alternately on leaft and right sides eg.., *Ranunculus, Heliotropium*.



A. Helicoid cyme outline plan, B. *Myosotis palustris*. **A. Scorpoid cyme outline plan B. *Ranunculus bulbosus*.**



(ii) Biparous cyme (= Dichasial cyme)

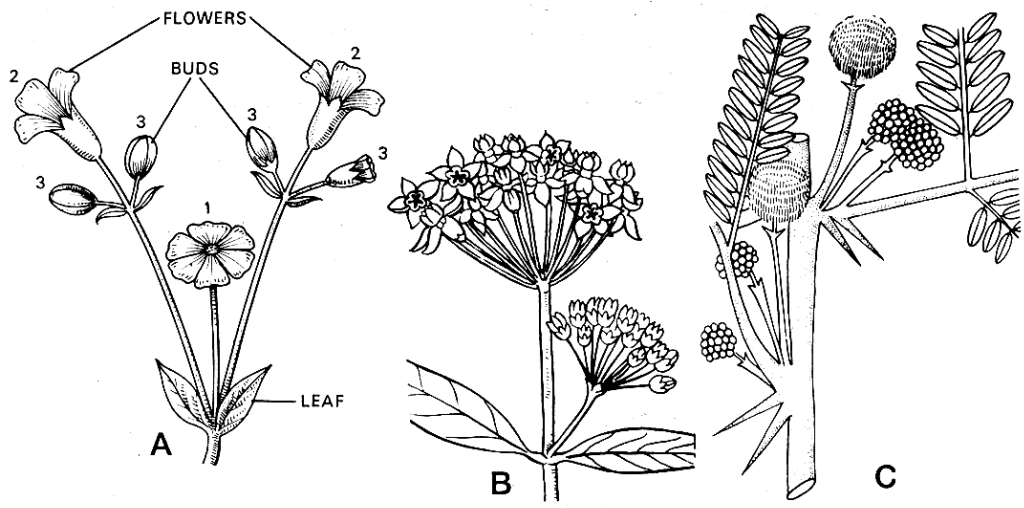
- In this case peduncle bears a terminal flower and stops growing. This peduncle bears two bracts at a node from which arise two branches, one on each side which also terminate in flowers. (Thus there are 3 flowers–oldest in the center). From the pedicel of each lateral flowers further branching may arise repeatedly e.g., *Stellaria media, Spergula arvensis, Dianthus chinensis, Clerodendron*.

(iii) Multiparous cyme (= Polychasial cyme)

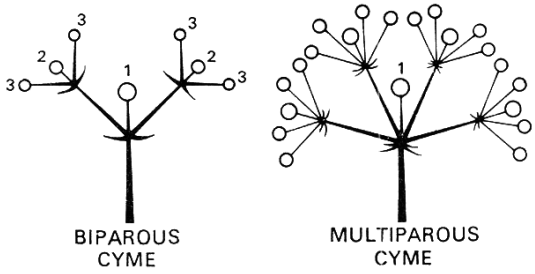
- The peduncle bears a single terminal flower and below it more than two lateral branches arise at a node. They also bear terminal flowers. The oldest flowers are in the center and terminates the main peduncle. In *Hamelia* this simple polychasial cyme become biparous and ultimately uniparous during further branching. In *Calotropis* there is umbellate cyme i.e., groups of multiparous cymes in which main peduncle becomes very much short.

(iv) Cymose Head

- In *Acacia nilotica* (Keekar) and *Albizzia lebbek,* the peduncle is reduced or condensed to a circular disc. It bears sessils flowers (or subsessile). The oldest flower is in the center and youngest towards the periphery of the disc (centrifugal). The flowers form a compact globose head.



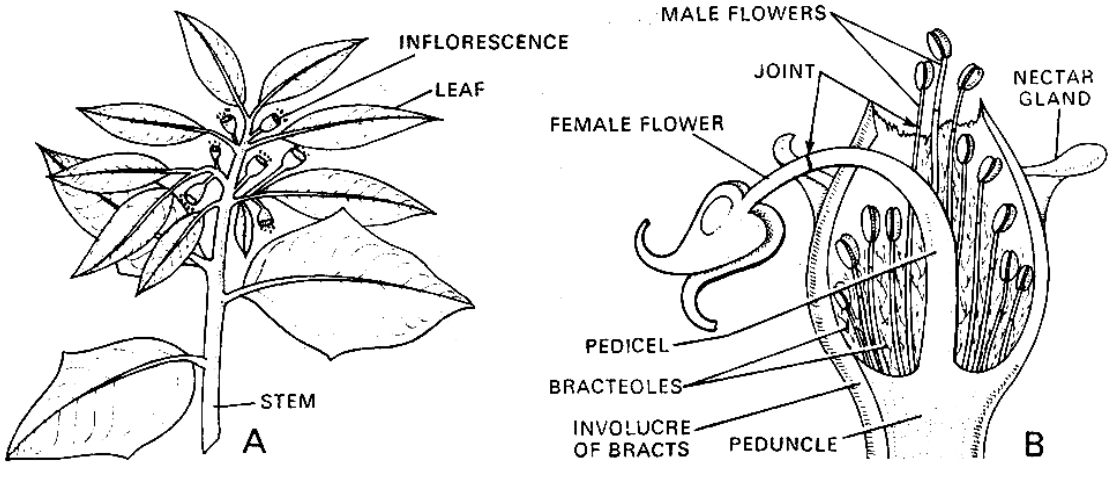
A. Dichasial cyme *Dianthus chinensis,* B. Polychasial cyme *Hamelia*, C. Cymose head of *Acacia*.



3. SPECIAL TYPE OF INFLORESCENCE

(i) Cyathium

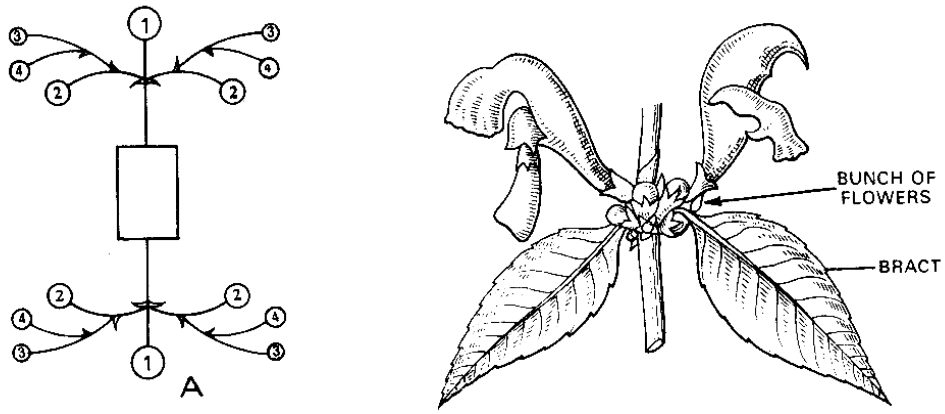
- The bracts or the involucre become fused to form a cup shaped structure (usually 5 bracts). Some secretary glands are borne on the margin of involucral cup. This cup completely encloses a single female flower surrounded by large number of male flowers. The male flowers are represented by single stamen borne on a short or long pedicel (joint is regarded as thalamus). The male flowers are with hairy bracts. The single female flower is represented by a tricarpellary, syncarpous gynoecium borne on a long pedicel. In *Euphorbia splendens* and Poinsettea (*Euphorbia pulcherrima*) the cyathium are surrounded by brightly coloured bracts. This type of inflorescence is characteristic of *Euphorbia* genus.



Cyathium Inflorescence A. Twig with inflorescence, B.L.S. of one inflorescence showing a central female flower surrounded by large number of male flowers.

(ii) Verticillaster

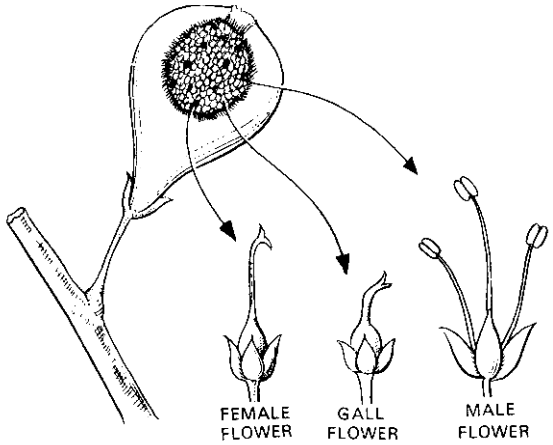
- It is a condensed dichasial cyme type of inflorescence. On the main axis there are two opposite bracts at each node. In the axil of each bract arises a large flower on the sides of which are borne two smaller flowers (e.g., dichasial cyme). But all the three flowers are sessile or subsessile. After this stage each dischasial cyme changes into monochasial cyme of scorpoid type. Thus is one cluster there are 7 flowers in all e.g., *Ocimum* (Tulsi), *Leucus, Salvia* (Lamiaceae).



Verticillaster inflorescence (*Ocimum*). A. Outline plan, B. Actual inflorescence.

(iii) Hypanthodium

- The fleshy receptacle forms a hollow pear shaped cavity with a narrow apical opening guarded by hairy structures. The flowers are borne on the inner wall of the cavity. At the base of the cavity are developed normal female flowers and male flowers towards the mouth. In between the two on the sides of cavity are developed female gall flowers e.g., *Ficus* (Banyan, Fig, Gular).



Hypanthodium inflorescence (*Ficus*).

FLOWER

- Flower is a group of reproductive organs of the flowering plants, which develops fruits and seeds and thus helps in forming new offspring of the plant.
- From morphological point of view flower is a highly condensed and modified shoot. Its function is reproduction.
- In a typical flower there are four types of structures called floral leaves. These are arranged in four whorls.
- Floral leaves are arranged on the swollen upper parts of flower stalk.
- The flower stalk is called pedicel and the swollen upper part is called Thalamus (=torus).
- In the thalamus are present nodes and highly reduced internodes. Floral leaves are borne on the nodes in whorls.
- The four floral whorls taken from periphery to centre are as follows :–

1. CALYX

- It is the outermost whorl and floral leaves of this whorl are called sepals. Their function is that of protection of inner whorls and also that of photosynthesis when green.

2. COROLLA

- It is the second whorl of floral leaves which are called petals. These protect the inner two whorls and also function for attraction of insects for pollination.
- Calyx and corolla are called accessory whorls of the flower.
- In some plants although two whorls are present they are not differentiated from one another. In such a case both whorls are called perianth and each part of the perianth is called tepal.
- If accessory whorls are absent in a flower it is called achlamydous flower (naked flower). If out of the two accessory whorls only one whorl is present it is called monochlamydous flower and if both whorls are present it is called dichlamydous flower.

3. ANDROECIUM

- This is third whorl of floral leaves and is the male reproductive organ of the flower. Each modified floral leaf is called microsporophyll or stamen.

4. GYNOECIUM (=Pistil)

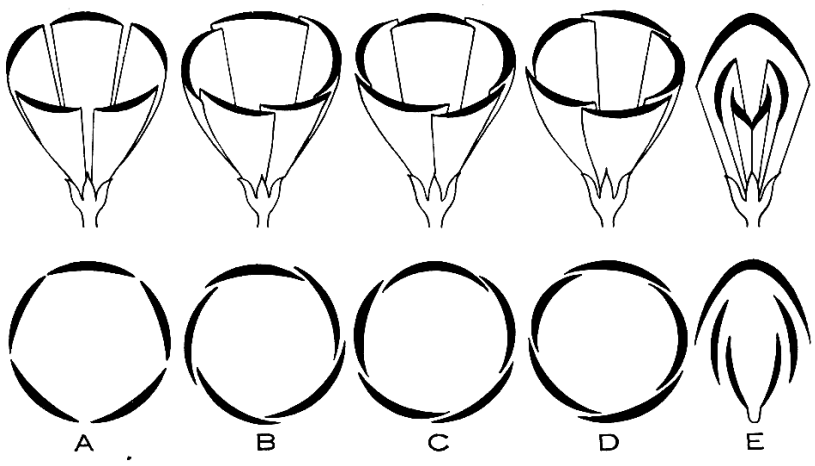
- This is the last (fourth) central whorl of floral leaves and is the female reproductive organ of the flower. Each modified floral leaf is called megasporophyll or carpel. Each gynoecium is made up of one or more megasporophylls (carpels).
- The last two whorls are called essential whorls of the flower. In most flowers stamens and carpels are found in the same flower, such flowers are called hermaphrodite or bisexual flowers e.g., China rose, pea, cotton.
- In other flowers only one of the essential whorls is found. Such flowers are called unisexual flowers e.g., Cucurbits, Mulberry etc.
- Flowers which have only stamens are called staminate flowers and those in which only carpels are present as pistillate flowers.
- In most flowers all the four whorls are found, such flowers are called complete e.g., Cotton, China rose.
- If from a flower out of the four whorls any one whorl is absent it is called incomplete flower e.g., Cucurbits.
- These terms are used for the plants. If a plant has bisexual, unisexual as well as neutral flowers it is called Polygamous plant e.g., Mango.
- If a plant has either bisexual flowers e.g., Rose or although flowers are either staminate or pistillate but are borne on the same plant, the plant is called Monoecious.
- If a plant bears only male flowers it is called male plant and if it bears only pistillate flowers it is called female plant and such plants are called Dioecious.

AESTIVATION

- The mode of arrangement of petals (also sepals) in a flower bud with respect to members of the same whorl is known as aestivation. It may be of the following types :–

1. Valvate

- When the petals of a whorl lie close to each other i.e., neither overlap the margin of the adjacent petal nor are overlapped by the margin of the adjacent petal e.g., Mustard.



Different types of aestivation of Calyx and Corolla A. Valvate, B. Twisted, C. Imbricate, D. Quincuncial, E. Vexillary.

2. Twisted or contorted

- When one margin of a petal of a whorl covers the margin of the adjacent petal and the other margin is covered over by the margin of adjacent petal. This order may be clockwise or anticlockwise e.g., China rose.

3. Imbricate

- When both margins of one of the petals are covered by the others and both margins of another one are external i.e., covering others and of the remaining three petals one margin is overlapped and the other overlapping e.g., *Cassia, Caesalpinia.*

4. Quincuncial

- It is a special type of imbricate aestivation in which 2 petals are external (both margins overlapping), 2 are internal (both margins overlapped) and in one petal one margin is overlapped and other overlapping e.g., Calyx of *Cucurbita maxima, Ranunculus*.

5. Vexillary

- Papilionaceous corolla.

FRUIT

- As a result of fertilization the ovule develops into a seed, the ovary wall forms the pericarp and the ovary, thus gives rise to a fruit. The fruits developing from the ovary are said to be true fruits.
- Rarely, the actual fruits gets burried inside and hence, the fruits so formed are called false fruits e.g., *Dillenia*, Apple.
- When a fruit develops from an unfertilized ovary, it is said to be parthenocarpic in origin and the phenomenon as parthenocarpy.
- The fruits are formed in angiosperms only because in gymnosperms the seeds are naked.
- The fruits are generally classified into three categories as under :–

A. Simple fruits : They develop from simple monocarpellary or multicarpellary syncarpous ovary of a single flower.

B. Aggregate fruits : They develop from apocarpous ovary of a single flower eg. custard apple (sitaphal).

C. Composite or multiple fruits : They develop from all the ovaries of an inflorescence eg. pineapple.

A. SIMPLE FRUITS

They are of two types :

a. Dry fruits : They possess a dry, membranous or leathery or woody pericarp which is not divided into 3parts/ layers.

b. Succulent fruits = fleshy fruits : They possess a fleshy pericarp hence they are also called as fleshy fruits.

a. **Dry fruits ;** They have been divided into three categories on the basis of their mode of dehiscence.

I **Indehiscent fruit :** They are single seeded fruits and hence they do not dehisce.

II **Schizocarpic fruits :** They dehisce into one-sided compartments called mericarp or cocci. They may remain attached to a carpophore.

III **Dehiscent fruits :** They are many seeded fruits and hence they dehisce.

I INDEHISCENT OR ACHENIAL FRUITS

They have been divided into 5 categories on the basis of pericarp character.

(i) Achene

- It develops from a superior ovary and has pericarp free form seed coat. e.g., *Mirabilis,* Polygonaceae (*Polygonum*). The achene of *Mirabilis* enclosed in the calyx tube is sometimes described as schleranthium.

(ii) Caryopsis

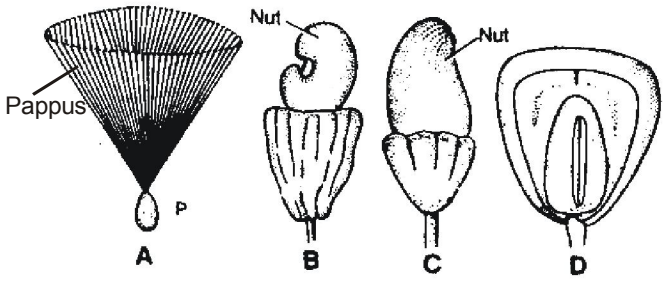
- It develops from superior ovary and the pericarp is fused with the testa. e.g., Gramineae, wheat, rice.

(iii) Cypsela

- It develops from inferior ovary and has a pericarp free from the seed coat e.g., Compositae (*Helianthus*/Sunflower).

(iv) Nut

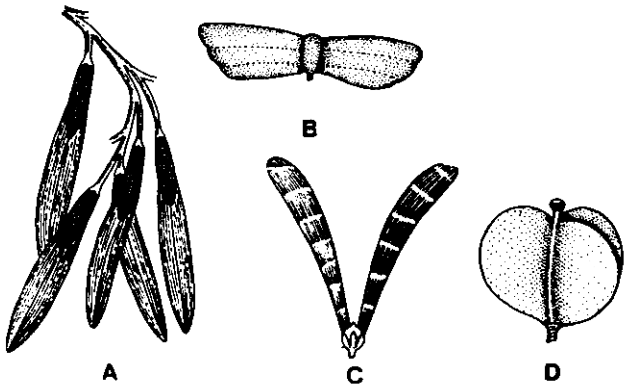
- It has a hard and woody pericarp e.g., *Anacardium* (cashew nut), *Litchi. Quercus* (Oak), *Trapa* (water chestnut), *Casuarina.*



Dry, indehiscent fruits : A. Cypsela of Compositae, B. Nut of *Anacardium*, C. Nut of *Semicarpus*, D. Caryopsis of Zea.

(v) Samara – Single seeded sometimes double seeded.

- In these fruits the pericarp is winged e.g., *Holeoptela* (elm), *Hiptage, Fraxinus, Dioscorea, Gomphrena*. In *Ulmus, Shorea* and *Dipterocarpus* the wings are derived from calyx. Such fruits are described as samaroid.



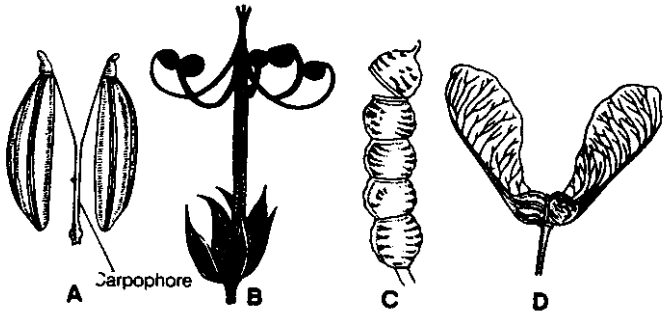
Samara fruits : A. *Fraxinus,* B. *Terminalia*, C. *Hopea*, D. *Dioscorea*.

II SCHIZOCARPIC FRUITS

They have been sub-divided on the basis of the number of mericarps in which they dehisce.

(i) Cremocarp

- It dehisces into two mericarps which remain attached to a carpophore e.g., Carrot, Umbelliferae (*Coriandrum*).



Schizocarpic fruits : A. Cremocarp of Umbelliferae, B. Carcerulus of *Geranium*, C. Lomentum of *Acacia* D. Double samara of *Acer*.

(ii) Regma

- It dehisces into three mericarps e.g., Euphorbiaceae (*Ricinus*).

(iii) Carcerulus

- It dehisces into four or more mericarps. In Labiatae (*Ocimum*) the fruit breaks into four cocci but in *Geranium* it breaks into 4–7 cocci. eg. *Ocimum* (Tulsi), *Hollyhock*.

(iv) Double samara

- The fruit of *Acer* (maple) is a double winged, two-seeded samara which breaks into two cocci.

(v) Lomentum

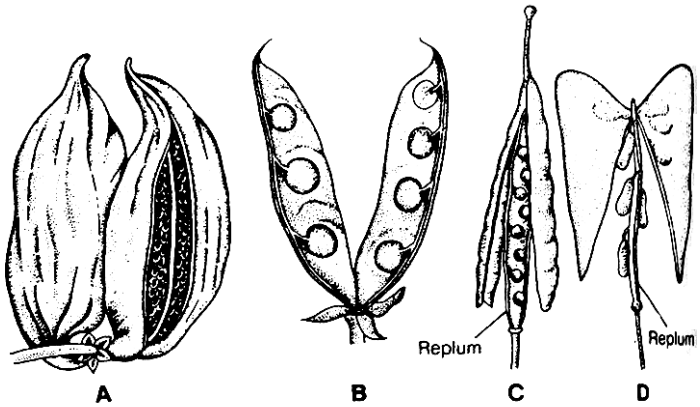
- It is a constricted legume. The fruit is constricted in between the seeds. It dehisces into 1–seeded segments e.g., *Ground nut, Tamarind, Acacia*.

III DEHISCENT OR CAPSULAR FRUITS

They have been sub-divided on the basis of their mode of dehiscence into four broad categories as under :

(i) Follicle

- It develops from monocarpellary ovary and dehisces by a single suture e.g., *Delphinium, Calotropis*.



Dehiscent fruits : A. Follicles of *Calotropis*, B. Legume of *Pisum*, C. Siliqua of *Brassica*, D. Silicula of *Capsella*.

(ii) Legume or Pod

- It also develops from monocarpellary ovary but dehisces by both the sutures from apex down-ward e.g., Garden pea (*Pisum*), Leguminosae .

(iii) Siliqua

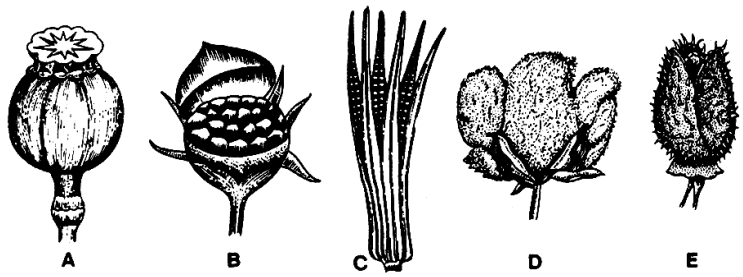
- It develops from a bicarpellary, bilocular ovary having a false septum in between, called replum. It also dehisces by both sutures, but from base upward e.g., Mustard, Radish, Cruciferae. There is an almost identical fruit called silicula, *Capsella, Iberis,* found in some members of Cruciferae. The two fruits differ in some important characteristics.

(iv) Capsule

- It develops from bi-to-multicarpellary, syncarpous and superior ovary. On the basis of their mode dehiscence we differentiate three types of capsules :

(a) Porous capsule

- It dehisces by several pores formed at the top of the fruit e.g., *Papaver*.



Capsule fruits : A. Porous capsule of *Papaver*, B. Transverse capsule of *Portulaca*, C,D,E : Valvular Capsules C, *Abelmoschus*, D. *Gossypium*, E. *Datura*.

(b) Transverse capsule

- This fruit dehisces transversely removing the lid and exposing the box of seeds; it is also called pyxis e.g., *Portulaca, Celosia*.

(c) Valvular capsule

This fruit dehisces by longitudinal slits. Depending upon manner of dehiscence, it is sub-divided into three categories eg. Cotton, Datura.

- A capsule developing from an inferior ovary is called diplotegia. It is commonly seen in *Eucalyptus, Iris, Canna* etc.

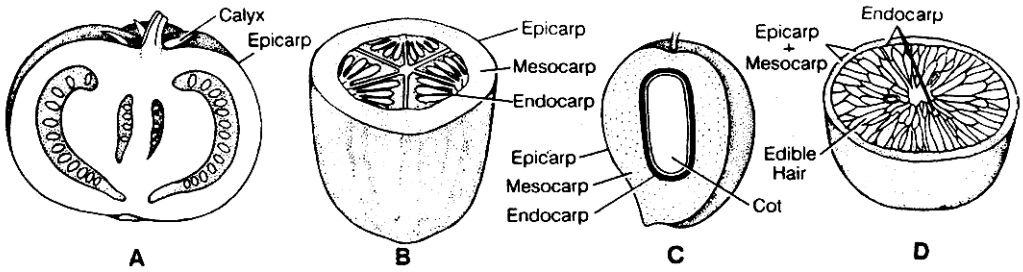
b. SUCCULENT OR FLESHY OR BACCATE FRUITS (SIMPLE FRUITS)

They are divided into two major categories : –

I In the first category, the pericarp is distinguishable into three layers, an outer epicarp, middle mesocarp and an inner endocarp.

(i) Berry or Bacca

- They have a thin epicarp, fleshy mesocarp and a thin endocarp. They usually develop from a superior ovary and their seeds get detached from the placenta at maturity e.g, Tomato, (Solanaceae), Papaya, Groups, Banana, Guava, Date palm.



Succlent fruits : A. Berry of *Lycopersicon*, B. Pepo of *Cucurbitaceae*, C. Drupe of *Mangifera*, D. Hesperidium of *Citrus*.

(ii) Pepo

- Here also, the epicarp is thin, mesocarp fleshy and endocarp thin. It, however, develops from an inferior ovary and the seeds remain attached to placenta even at maturity e.g., *Cucurbita, Cucumber* (Cucurbitaceae).

(iii) Drupe

- They are single seeded fruits characterised by the presence of a stony endocarp. The epicarp is thin and mesocarp fleshy. They are also called 'stone fruits' e.g., mango (*mangifera*), coconut (*cocos*), Plum. In coconut the mesocarp becomes fibrous.

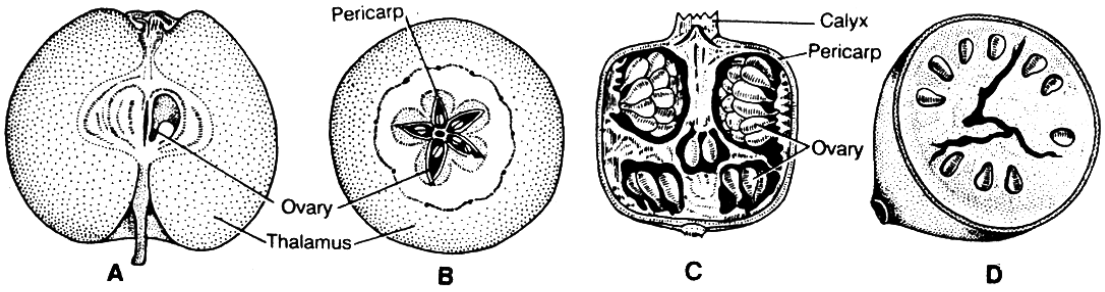
(iv) Hesperidium

- Here the epicarp and mesocarp are fused to form the rind. The endocarp is thin and folded. Juicy, unicelled, endocarpic hair are also present. The fruit is many chambered e.g., *Citrus* (lemon, orange).

II In the second category the pericarp is not distinguishable into distinct layers. They include the following :–

(i) Pome

- It develops from a syncarpous and inferior ovary. The fleshy thalamus surrounds the ovary e.g., apple (*Pyrus* sp.), pear (*Pyrus* sp.).



Succulent fruits : A–B. Pome of apple in L.S. and T.S. , C. Balausta of *Punica* in L.S., D. Amphisarca of *Aegle* in T.S.

(ii) Balausta

- The ovary is inferior and the epicorp & mesocarp are hard endocarp is membranous & remains expanded in between the seeds, e.g., pomegranate (*Punica*).

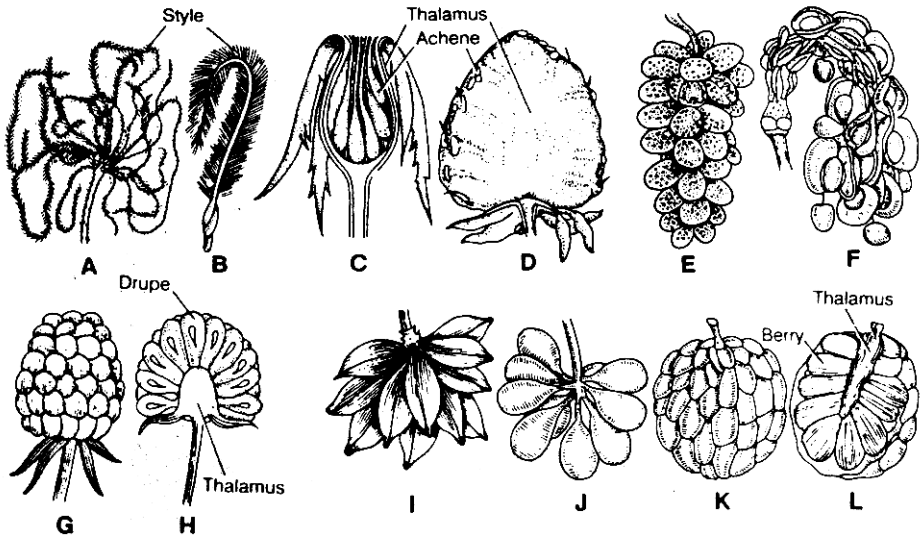
(iii) Amphisarca

- Here the pericarp is stony. The ovary is superior and the placenta is fleshy e.g., wood apple (*Aegle*), elephant apple (*Feronia*).

B. AGGREGATE FRUITS

- Since they develops from an apocarpous ovary, every carpel develops into a simple fruit. As a result, it becomes an aggregation or collection (or etaerio) of simple fruits. They are of the following types :–

I **Etaerio of achenes :** e.g., *Naravelia, Clematis, Ranunculus, Fragaria,* Rose, Strawberry etc.



Aggregate fruits : A. Etaerio of achenes of *Naravelia*, B. Single achene with feathery style, C. Etaerio of achenes of *Rosa*, D. Elaerio of achenes of *Fragaria*, E–F. Etaerio of follicles, E. *Michelia,* F. *Magnolia,* G–H. Etaerio of drupes of *Rubus*, G. External view, H. Fruit in L.S., I–L. Etaerio of berries, I. *Artabotrys*, J. *Polyalthia*, K. *Anona*.

II **Etaerio of follicles :** e.g., *Cabomba, Magnolia, Michelia, Asclepias, Calotropis, Aconitum* etc.

III **Etaerio of drupes :** e.g., *Rubus, Resberry.*

IV **Etaerio of berries :** e.g., *Anona, Artabotrys, Polyalthia,* Custard apple etc.

V **Etaerio of nuts :** e.g., *Nelumbo*.

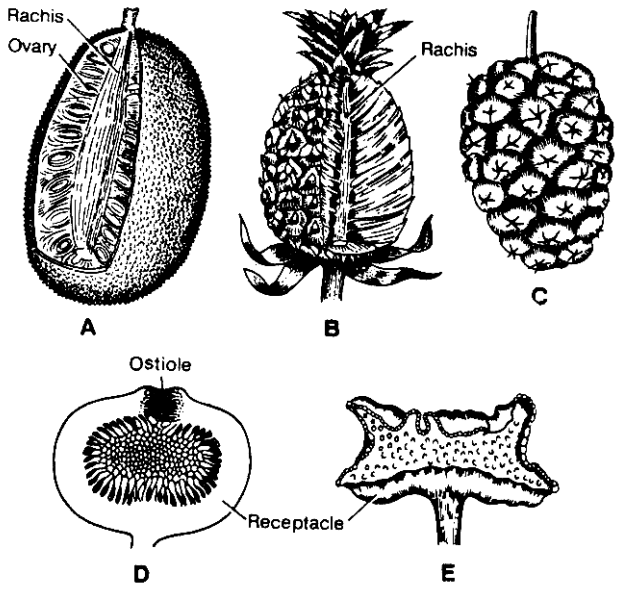
VI **Etaerio of samaras :** e.g., *Liriodendron*.

C. COMPITE OR MULTIPLE FRUITS

They are of the following types :–

I **Sorosis**

- It develops from a spadix or catkin inflorescence e.g., jack fruit (*Artocarpus*), pine apple (*Ananas*), mulbery (*Morus*).



Composite fruits : A–C. Sorosis, A. *Artocarpus* (Jack fruit), B. *Ananas* (Pine apple), C. *Morus* (Mulberry), D–E, Syconus, D. *Ficus*, E. *Dorstenia*.

II **Syconus**

- It develops from a hypanthodium inflorescence e.g., *Ficus.* In *Dorsteria* the syconium develops from a coenanthium inflorescence. In both the cases the true fruits are achenes.

SEED

- On the basis of embryo structure, the seeds have been classified into two categories as under ;

1. **Dicotyledonous :** In these seeds the embryo has two cotyledons.

2. **Monocotyledonous :** These seeds possess an embryo having only one cotyledon.

1. DICOTYLEDONOUS SEEDS

They are of three types :

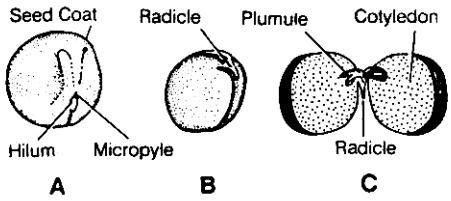
a. **Non-endospermic or exalbuminous :** e.g., beam, gram, pea.

b. **Endospermic or albuminous :** e.g., castor, tamarind.

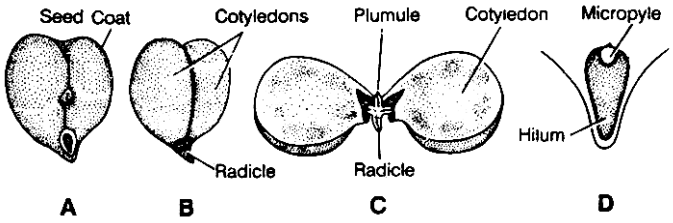
c. **Endospermic and perispermic :** e.g., betel, black pepper.

***Pisum sativum* (garden pea)**

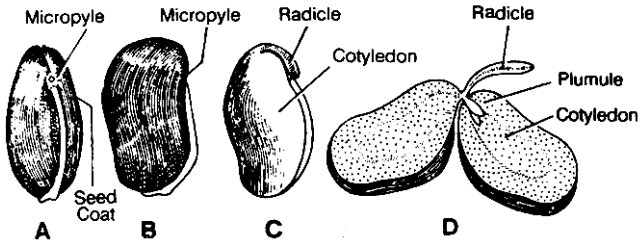
- The pea seed is covered by a seed coat which is distinguishable into an outer thick testa and inner thin tegmen. The seed coat carries a funicular scar on its surface, called hilum. The micropyle lies near the hilum. The micropyle of seed is meant for absorption of water. After removing the seed coat the embryo (kernel) becomes visible. The embryo is distinguishable into an embryonic axis or tigellum bearing two fleshy cotyledons laterally. The outer end of the axis lying in between the cotyledons, which forms the root is called radicle. The outer end of the axis lying in between the cotyledons, which forms the shoot is named is plumule. The point of attachment of the cotyledons to the embryonic axis constitutes the first or the cotyledonary node. This is true for gram and bean seeds also.



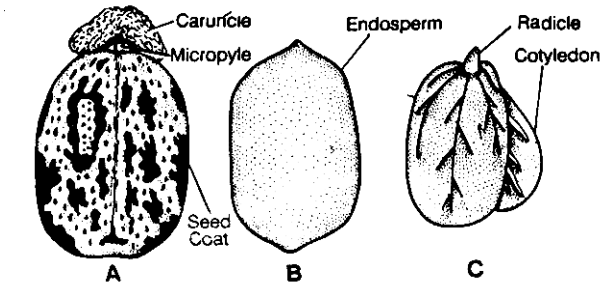
Structure of pea seed, A. Entire seed, B. Seed coat removed, C. Cotyledons of the embryo split open.



Structure of gram seed, A. Entire seed, B. Sheed coat removed, C. Cotyledons of the embryo split open, D. Hilum and micropyle.



Structure of bean seed, A. Entire seed in side view, B. Entire seed in micropylar view, C. Seed coat removed, D. Cotyledons of the embryo split open.



Structure of castor seed, A. Entire seed, B. Seed coat removed, C. Embryo with cotyledons separated.

MONOCOTYLEDONOUS SEEDS

Like dicots, the monocot seeds have been also divided into three categories as under :

(i) **Non-endospermic :** e.g., *Pothos, Vallisneria, Alisma* etc.

(ii) **Endospermic :** e.g., *Zea, Oryza, Triticum* etc.

(iii) **Endospermic and perispermic :** e.g., *Zingiber, Elyttaria, Curcuma* etc.

(i) Non-endospermic seeds

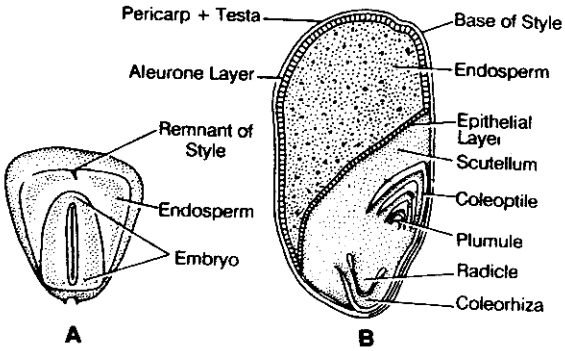
- The seed is covered by a seed coat which carries a funicular scar (hilum) near the micropyle. The embryo appears after removal of the seed coat. It is distinguishable into a single cotyledon and the radicle. The embryo is curved in *Alisma*.

(ii) Endospermic seeds

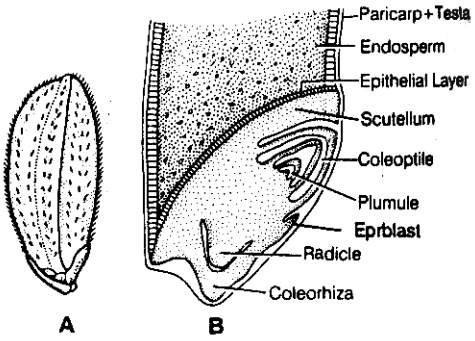
- The grain of maize, rice or wheat is a caryopsis. The testa is fused with pericarp. This is followed by an aleurone layer. It comprise aleurone cells having thick walls, Each cell has several aleurone grains. An aleurone grain is composed of protein, phytin, phospholipids and carbohydrates. Each grain contains two types of inclusions in the ground substance :

a. Globoids in globoidal cavities having phytin and lipids.

b. Protein-carbohydrate bodies



Structure of maize grain, A.Entire grain, L.S. of the grain.



Structure of rice grain, A. Entire grain, B. L.S. of the lower B. part of the grain.

- Each aleurone grain is surrounded by several peculiar organelles called spherosomes. The aleurone layer encloses the endosperm. The embryo lies laterally near the base of the grain. On the upper side of the embryo lies a shield cotyledon called scutellum. The scutellum is separated from the endosperm by an epithelial layer. The embryonic axis lies on the outer lateral side of the scutellum. Its lower end in the radicle which remains covered by a sheath called coleorhiza. The upper part of the axis is the plumule which is surrounded by a tubular sheath called coleoptile.
- In rice, a rudimentary second cotyledon is also found. It is called epiblast. In coconut the seed contains liquid endosperm. In the members of Zingiberaceae, the seeds are endospermic and perispermic.

IMPORTANT COMPETITION TIPS

1. *In Curcuma (Turmeric) swelling occur only near the tips. They are called as **nodulose** roots.*
2. ***Buttress** roots are present in plants like Ficus, Bombax, Terminalia where they appear from basal parts of main stem. They are vertically elongated and horizontal pressed.*
3. *Some times roots at nodes store gases and become inflated thus help in floating on the surface of roots. Such floating roots are present in Jussiaea (=Ludwigia) and Pistia.*
4. *In Orchids like Vanda, some roots freely hang in air, they are provided with outer covering called **velamen** by means of which moisture from atmosphere is absorbed.*
5. ***Clinging** or **climbing** roots help the plants in climbing by penetrating the cracks of the support e.g. Pothos (money plant), Ficus pumila, Hedera helix, Piper betle (betel), Tecoma.*
6. *Podostemon is plant made up only of roots. It has some roots called **haptera** for fixing to the ground.*
7. *The part of the plant that develops from radicle is called **primary root**. Lateral roots are **endogenous** i.e. arise from pericycle while lateral shoots arise exogenously i.e. arise from cortex.*
8. *In hydrophytes instead of root cap, a **root pocket** is present e.g., Pistia, Lemna.*
9. ***Seminal roots** are new roots growing near the base of radicle in moncots.*
10. *In Wolffia - a floating plant (smallest angiosperm) and Utricularia - a submerged hydrophyte, there are no roots.*
11. *Roots of some plants : like Pinus bear fungal hyphae and do not have root hair and root caps. Such roots are called **mycorrhizal roots**.*
12. *Velamen a spong tissue on roots is characteristic of epiphytes.*
13. *Root cap is continuously produced from root apex.*
14. *Once lost, root pockets cannot be regenerated.*
15. *Suckers developing in **Musa** are known as **Sword suckers**.*
16. *A plant with reduced stem or without a stem is called **acaulescent**.*
17. ***Cyanodon** (doob grass) is a evergreen herb (perennial).*
18. ***Sobole** is underground runner of **Andropygon** and **Saccharum spontaneum**.*
19. ***Ulex** bears both stem thorns and leaf spines.*
20. *Only first internode is tuberous in **Bulbophyllum**.*
21. *Whole stem is tuberous in knol-kohl.*
22. ***Pseudobulb** is thickened part of aerial stem (one or few internodes) in orchids and modified for storing water and other reserves.*
23. *Woody climber or twiner is called **liana**.*
24. ***Belt's corpuscles** are the glands producing edible materials at the apices of leaflets in **Acacia sphaerocephala**.*
25. ***Monophyllea** is a plant with single leaf.*
26. *The semiamplexicaul or cup-like leaf base protects the axillary bud in **Platanus** and **Robinia**.*
27. *Petiole is hollow, tubular or fistular in **Carica papaya.***
28. *Leaf with largest diameter of about 1.8 m. is of **Victoria amazonia** (Aomazon lily).*
29. *Leaf mosaic is characteristic of sciophytes where leaves of various size and shape are crowded forming a mosaic.*
30. ***Stipel** is stipule like outgrowth at the base of leaflets in sub-family Papilionatae of family Leguminosae.*
31. *Longest leaf is of **Raphia vinifera** (10-15 m.)*
32. *In **Berberis**, whole leaf is modified into spine.*
33. *Bamboo is tallest grass. It is also considered as tallest shrub or arborescent grass.*
34. *In **Quisqualis,** the petiole becomes herdened and pointed after the lemina falls off (spinous petiole).*

35. *A plant having normal root system initially but later becoming epiphyte is called **hemi-epiphyte**. A plant with normal root system initially but later becoming unconnecting climbing epiphyte e.g., Monstera, Scindapsus is called **pseudo-epiphyte**.*
36. ***Wolffia** (less than 0.1 mm) is smallest angiosperm.*
37. ***Eucalyptus regnans** is the tallest plant with height of more than 114 m. (375 ft.)*
38. *A gymnosperm **Sequoia semprvirens** (red wood tree) is most massive plant which is over 111 m. tall and more than 24 m. in girth.*
39. ***Zostera** is marine angiosperm.*
40. ***Pingnicula** (butterwort) bears rosette free floating aquatic with leaves similar to **Dionoea** for trapping small animals.*
41. *The characteristic foul odgour of onion is due to an oil like organic compound of **sulphur allyl sulphide** formed in fleshy leaves.*
42. *Antidiabetic effect of garlic is due to the presence of sulphur containing amino acid S-allyl cystine sulphoxide (SACS).*
43. ***Involucel** is the whorl of small bracts at the base of secondary umbel/umbellet.*
44. ***Anthotaxis** is the arrangement of flowers on the axis of peduncle e.g. acropetal, basipetal, centripetal.*
45. ***Strobile** is a spike in which the flowers develop in the axils of persistent membranous bracts e.g **Humulus** (hop).*
46. ***Thyrsus** is a type of mixed inflorescence when cymose clusters are arranged actropetally e.g. grapevine.*
47. ***Puya raimondii (32 ft.) is the largest inflorescence of world.***
48. ***Coenanthium** is open hypanthodium.*
49. *Petaloid bract is found in **Bougainvillea**.*
50. *Largest Indian inflorescence is **Amorphophallus.***
51. *In **rhipidium scorpioid cyme,** the lateral branches are present on same plane e.g. **Solanum nigrum**.*
52. *In **cincinnus scorpioid cyme,** the lateral branches are present on angular planes.*
53. *Silicula type of fruit resembles siliqua but its breadth and length equal.*
54. *In jack fruit (Artocarpus integrifolia) pistillate flowers are developed very close to each other around the rachis.*
55. *In lotus, thalamus becomes spong and some achenes are embedded in it.*
56. *Seeds of some plants e.g. orchids are minute, dry and lighter than sand particles.*
57. *In fruits of Boerhaavia and Cleome, **sticky glands** are present which stick to the grazing animals and help in dispersal.*
58. *Lodoicea maldivica (double coconut) is largest fruit and largest seed.*
59. *Mango is **National fruit** of India.*
60. *Study of seeds is called **spermology**.*
61. *Juicy endocarpic hair are edible in orange, lime etc.*
62. *In spurious or **false fruits**, parts other than ovary **take part** in the formation of fruit.*
63. *Bitter taste of some cucurbits is due to presence of triterpenes.*
64. *Coconut (drupe), water chestnut (drupe), Peanut, groundnut (lomentaceous pod), betelnut (berry), pinenut (seed) are examples of **false nut***

EXERCISE

Q.1 In *Ipomoea batatas*/Sweet potato the food is stored in –
[1] Root tuber [2] Stem tuber [3] Bud [4] Leaves

Q.2 Pneumatophores or breathing roots occur in –
[1] Hydrophytes [2] Epiphytes [3] Xerophytes [4] Mangrove plants

Q.3 Haustoria or sucking roots occur in –
[1] Betel [2] Orchids [3] *Cuscuta* [4] *Tinospora*

Q.4 Velamen is present in –
[1] Tuberous roots [2] Epiphytic roots [3] Breathing roots [4] Parasitic roots

Q.5 Lateral roots originate from –
[1] Cortex [2] Epidermis [3] Endodermis [4] Pericycle

Q.6 Velamen takes part in –
[1] Absorption of moisture from air [2] Absorption of water from soil
[3] Exchange of gases [4] Transpiration

Q.7 Lateral roots arise from primordia developed by division of –
[1] Pericycle cells in between two protoxylem points [2] Pericycle cells opposite protoxylem points
[3] Endodermis cells in between two protoxylem points [4] Endodermis opposite protoxylem points

Q.8 Economically important edible part of *Ipomoea batatas* is –
[1] Rhizome [2] Stem tuber [3] Underground fruit [4] Underground root tuber

Q.9 Stilt roots occur in –
[1] Groundnut/*Helianthus* [2] Rice [3] Sugarcane/Maize [4] Wheat

Q.10 Velamen absorbs moisture from –
[1] Air [2] Root [3] Leaves [4] Mineral salts

Q.11 Nodulated roots occur in –
[1] Leguminosae [2] Solanaceae [3] Malvaceae [4] Papilionatae

Q.12 Thick roots hanging down from Banyan tree are –
[1] Prop roots [2] Stilt roots [3] Pneumatophores [4] Buttress roots

Q.13 Climbing roots occur in –
[1] *Vanilla* [2] *Vanda* [3] *Pongamia* [4] *Taeniophyllum*

Q.14 Velamen containing structures of epiphyte *Vanda* are –
[1] Stems [2] Absorbing roots [3] Hanging roots [4] Clinging roots

Q.15 *Pandanus* possesses –
[1] Stilt roots [2] Prop roots [3] Climbing roots [4] Tuberous roots

Q.16 Bacteria found in root nodules of legumes are –
[1] *Nitrobacter* [2] *Nitrosomonas* [3] *Rhizobium* [4] *Azotobacter*

Q.17 Root system grows from –
[1] Embryo of seed [2] Radicle of embryo [3] Plumule of embryo [4] Coleoptile

Q.18 Clinging roots occur in –
[1] Trapa [2] Orchid [3] Screwpine [4] Podostemon

Q.19 Penetrating roots of *Cuscuta* are –
[1] Haustoria [2] Stilt roots [3] Climbing roots [4] Assimilatory roots

Q.20 Pneumatophores occur in plants of –
[1] Sandy soil [2] Saline marshy soil [3] Marshy soil [4] Water

Q.21 A plant with photosynthetic roots is –
[1] *Trapa* [2] *Dahlia* [3] *Momordica* [4] *Mirabilis*

Q.22 Velamen is found in –
[1] Halophytes [2] Orchids [3] Ferns [4] Gymnosperms

Q.23 Storage roots found in clusters at base of stem are –
[1] Nodulose roots [2] Annulated roots [3] Tuberous roots [4] Fasciculated roots

Q.24 Pneumatophores are characteristic features of –
[1] *Hydrilla* [2] *Typha* [3] *Rhizophora/Sonneratia* [4] Banyan

Q.25 A fleshy root tapering at both ends is –
[1] Fusiform [2] Conical [3] Napiform [4] Tuberous

Q.26 Regions of root from base to root tip are –
[1] Maturation zone–Cell division zone–Elongation zone
[2] Maturation zone–Elongation zone–Cell division zone
[3] Cell division zone–Elongation zone–Maturation zone
[4] Elongation zone–Cell division zone–Maturation zone

Q.27 A plant with epidermis specialised to absorb moisture from air is –
[1] *Avicennia* [2] *Vanda* [3] *Rhizophora* [4] *Jussiaea*

Q.28 Hygroscopic roots occur in –
[1] *Vanda* [2] *Rhizophora* [3] *Bryophyllum* [4] All of the above

Q.29 A root is adventitious when it is –
[1] Swollen [2] Growing in marshy places
[3] Formed from plumule [4] Modified for storage

Q.30 Root nodules are not formed in nonleguminous plants because they grow in –
[1] Nitrogen deficient soils
[2] Soils having bacteria for converting nitrogen into usable form
[3] Soils rich in nitrogen
[4] All of the above

Q.31 Which of the following plants are used as green manure in crop fields and in sandy soils –
[1] *Crotalaria juncea* and *Alhagi camelorum* [2] *Calotropis procera* and *Phyllanthus niruri*
[3] *Saccharum munja* and *Lantana camara* [4] *Dichanthium annulatum* and *Azolla nilotica*

Q.32 Corm is –
[1] Underground shoot [2] Underground root
[3] Horizontal stem [4] Underground vertical stem

Q.33 Thorn of *Bougainvillea* is modified –
[1] Stem [2] Leaf [3] Floral bud [4] Root

Q.34 Bulb is modified –
[1] Leaf [2] Shoot [3] Root [4] Flower

Q.35 Potato is (underground) stem because it –
[1] Possesses axillary buds (eyes) [2] Lacks chlorophyll
[3] Does not bear roots [4] Contains reserve food

Q.36 Thorn is a stem structure because it –
[1] Develops from trunk [2] Develops from axillary bud
[3] Grows from external surface [4] Is pointed

Q.37 Citrus thorn/spine is actually modification of –
[1] Stem [2] Branch [3] Leaf [4] Stipule

Q.38 Most reduced stem occurs in –
[1] Corm [2] Rhizome [3] Stem tuber [4] Bulb

Q.39 In *Opuntia,* the spines are modifications of –
[1] Stems [2] Leaves [3] Roots [4] None of the above

Q.40 Stem modified into flattened photosynthetic structure is –
[1] Phyllode [2] Bulbil [3] Phylloclade [4] Tendril

Q.41 Floral bud tendril is found in –
[1] *Antigonon* [2] *Smilax* [3] Rose [4] *Bryophyllum*

Q.42 Stem takes part in storage and perennation in –
[1] Wheat [2] Groundnut [3] Radish [4] Ginger

Q.43 In *Opuntia*, the stem is modified into –
[1] Cladode [2] Phylloclade [3] Phyllode [4] Staminode

Q.44 Which is not a rhizome ?
[1] *Colocasia* [2] Lotus [3] Ginger [4] Turmeric

Q.45 Dichotomous branching occurs in –
[1] Liverworts [2] *Funaria* [3] *Dryopteris* [4] *Pinus*

Q.46 Ginger plant has an underground stem which is –
[1] Rhizome [2] Bulb [3] Tuber [4] Corm

Q.47 An underground specialised shoot with reduced disc like stem covered by fleshy leaves is –
[1] Bulb [2] Bulbil [3] Rhizome [4] Rhizophore

Q.48 Stem tendrils occur in –
[1] *Smilax* [2] *Gloriosa* [3] *Vitis* [4] *Lathyrus*

Q.49 Which of the following is not related to corm –
[1] Tunic [2] Lateral buds [3] Nodes [4] Scale leaves

Q.50 Eye of Potato is –
[1] Apical bud [2] Axillary bud [3] Accessory bud [4] Adventitious bud

Q.51 The fruits is chambered, developed from inferior ovary and has seeds with succulent testa in :
[1] Organe [2] Guava [3] Cucumber [4] Pomegranate

Q.52 The fleshy receptacle of syconus of fig encloses a number of :
[1] Samaras [2] Berries [3] Mericarps [4] Achenes

Q.53 Replum is present in the ovary of flower of :
[1] Mustard [2] Sun flower [3] Pea [4] Lemon

Q.54 Dry indehiscent single-seeded fruit formed from bicarpellary syncarpous inferior ovary is :
[1] Cypsela [2] Berry [3] Cremocarp [4] Caryopsis

Q.55 A fruit developed from hypanthodium inflorescence is called
[1] Syconus [2] Caryopsis [3] Hesperidium [4] Sorosis

Q.56 The condition where filamenta and anthers are fused throughout the enitre length is
[1] synandrous [2] gynandrous [3] protandrous [4] syngenesious

Q.57 What type of placentation is seen in sweet pea?
[1] Basal [2] Axile [3] Free central [4] Marginal

Q.58 Anthesis is a phenomenon which refers to
[1] reception of pollen by stigma [2] formation of pollen
[3] development of anther [4] opening of flower bud

Q.59 The order of opening of flower parts from the periphery towards the centre is called
[1] acropetal [2] centripetal [3] centrifugal [4] basipetal

Q.60 At root tip, number of divisions to produce 100 cells is
[1] 25 [2] 50 [3] 99 [4] 100

Q.61 In the following, succulent stem is found in

[1] *Saccharum* [2] *Musa* [3] *Euphorbia* [4] *Dryopteris*

Q.62 Whorled type of phyllotaxy is found in

[1] mustard [2] China rose [3] guava [4] Calotropis

(5) Alstonia

Q.63 In *Nepenthes* (pitcher plant), pitcher is the modification of

[1] leaf petiole [2] leaf base [3] leaf lamina [4] All of these

Q.64 Cyathium inflorescence shows

[1] scorpioid cyme showing central female, many peripheral male flowers

[2] scorpioid cyme showing central male, many peripheral female flowers

[3] dichasial cyme showing two whorls of 3 to 9 flowers

[4] dichasial cyme showing two whorls, one of male and another of female flowers

Q.65 In unilocular ovary with a single ovule the placentation

[1] marginal [2] basal [3] free central [4] axile

Q.66 Keel is characteristic of the flowers of

[1] gulmohur [2] *Cassia* [3] *Calotropis* [4] bean

Q.67 Ovary is half-inferior in the flowers of

[1] guava [2] plum [3] brinjal [4] cucumber

Q.68 When stigma shows feathery appearance, it is

[1] plumose [2] cymose [3] globulose [4] racemose

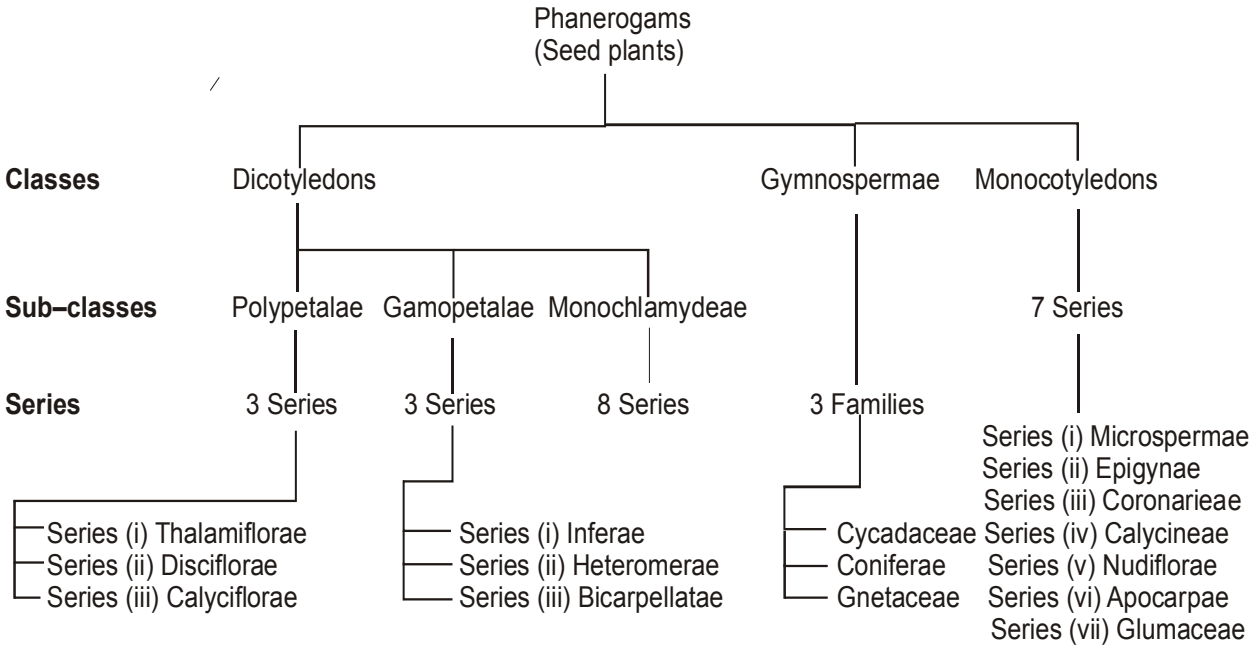
ANSWERY KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ans	1	4	3	2	4	1	1	4	3	1	4	1	1	3	1	3	2
Que.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Ans	2	1	2	1	2	4	3	1	2	2	1	3	2	1	4	1	2
Que.	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Ans	1	2	3	4	2	3	1	4	2	1	1	1	1	3	1	2	4
Que.	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
Ans	4	1	1	1	1	4	4	2	3	3	5	3	1	2	4	2	1

4 Plant Taxonomy (Families)

Bentham and Hooker's System of Classification (1862–83)

G. Bentham (1800 – 1884) and J. D. Hooker (1817 – 1911) presented their outstanding classification in *Genera Plantarum*. They divided the seed plants into Dicotyledons, Gymnosperms and Monocotyledons).



MERITS

- Each plant has been described either from the actual specimen or preserved herbarium sheets so that the descriptions are detailed as well as quite accurate.
- The system is highly practical and is useful to students of systematic botany for easy identification of species.
- The flora describes geographical distribution of species and genera.
- **Dicots begin with the order Ranales**. This order is actually primitive and indicates that Bentham and Hooker's system is quite natural system of classification bordering the phylogenetic one.
- Placing of monocots after the dicots is again a natural one and according to evolutionary trends.

- Larger genera have been divided into sub genera, each with specific number of species.
- The interpolation of series disciflorae in between thalamiflorae and calyciflorae is quite natural.

DEMERITS

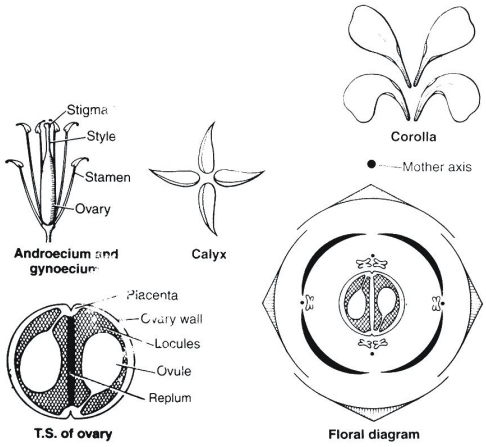
- Keeping gymnosperms in between dicots and monocots is anomalous.
- Subclass monochlamydeae is quite artificial.
- Placing of monochlamydeae after gamopetalae does not seem to be natural.
- Certain families of monochlamydeae are closely related to families in polypetalae, e.g., Chenopodiaceae and Caryophyllaceae.
- Placing of Orchidaceae in the beginning of monocotyledons is unnatural as it is one of the most advanced families of monocots. Similarly Compositae (Asteraceae) has been placed near the beginning of gamopetalae which is quite unnatural.
- Liliaceae has been separated from Amaryllidaceae merely on the basis of character of ovary without considering other characters.

FAMILY : CRUCIFERAE (BRASSICACEAE)

(MUSTARD FAMILY)

Floral Formula

$$\text{Ebr} \oplus \ \male \ K_{2+2}\, C_{4x}\, A_{2+4}\, \underline{G}_{(2)}$$



Parts of a flower and florai diagram of *Brassica campestris* (Yellow mustard)

Important Characters of Family Cruciferae

Habit – Usually herbs, some shrubs.

Leaf – Exstipulate, simple, alternate, cylindrical, usually entire, sometimes lobed, radical or cauline.

Inflorescence – Generally Raceme, sometimes corymbose raceme (eg. ***Iberis amara***).

Flower – Ebracteate, bisexual, actinomorphic, sometimes zygomorphic (eg. ***Iberis amara***) regular, Bimerous or tetramerous, hypogynous.

Calyx – 4, in whorls of 2 + 2, polysepalous.

Corolla – 4, polypetalous, cruciform, Each petal is divided into 2 parts long claw & broader limb.

Androecium – 6, polyandrous, in two whorls, in outer whorl 2 stamens and in inner whorl 4 stamens. Tetradynamous. (2 stamens in ***Coronopous***, 4 in ***Lepidium***). Nectaries are present at the base of anthers.

Gynoecium – Bicarpellary (Tricarpellary in ***Lepidium***), syncarpous, ovary superior, unilocular but becomes bilocular later on, parietal placentation, ovules campylotropous.

Fruit – Generally Siliqua, sometimes silicula (***Capsella, Iberis, Lepidium***) , and Lomentum (***Raphanus***).

Pollination – Both self and cross (by insects)

Other Important feature – The plant organs have pungent odour. This odour is due to the presence of sulphur containing glycosidic compounds.

Economic importance

1. Vegetables

(i) ***Raphanus sativus*** (radish) – Roots, leaves and fruits are eaten, Fusiform root.

(ii) ***Brassica oleracea*** – It has several varieties.

- ***B. oleracea* var. *gongylodes*** or **var. *caulorapa*** (knol - khol) – Edible part is fleshy stem.
- ***B. oleracea* var. *botrytis*** (cauliflower) – Edible part is fleshy inflorescence.
- ***B. oleracea* var. *capitata*** (cabbage) – Vegetative buds (fleshy leaves) are edible.
- ***B. oleracea* var. *gemmifera*** (button gobhi) – Vegetative buds are edible.

(iii) ***Brassica rapa* (turnip)** – Edible part is hypocotyl, Napiform root.

2. Oil

Oil is obtained from many species. The oil is used in cooking, pickles and soap production. Oil cake is used as cattle feeding and fertilizer.

Braassica campestris* var. *sarson (yellow mustard)

B. juncea (Local rye)

B. nigra (black rye)

B. napus (rape speed)

B. alba (white rye)

3. Medicinal plants

(i) Seeds of ***Lepidium sativum*** (Halima) are used in liver diseases.

4. Ornamental plants

(i) ***Iberis amara*** (candytuft) **(ii)** ***Cheiranthus cheiri*** (wall flower)

5. Weeds

(i) ***Capsella bursa – pastoris*** (shepherd's purse)

6. Condiments

(i) Seeds of ***Brassica alba*** (white mustard), ***B.nigra*** (black mustard) ***B. Juncea*** (brown mustard) are used condiments.

FAMILY : MALVACEAE

(COTTON FAMILY OR MALLOW FAMILY)

Floral Formula

$$Br \oplus \ \male\female \ Epi_{3-7} \ K_{(5)} \ C_5 \ A_{(\alpha)} \ \underline{G}_{(5-\alpha)}$$

Floral Diagram of Hibiscus rose – sinensis (Gurhal)

Important characters of family Malvaceae

Habit	–	Mostly herbs and shrubs.
Stem	–	Erect, Branched, Hairy.
Leaf	–	Stipulate, Simple, palmately lobed, multicostate reticulate venation, mucilaginous, hairy.
Inflorescence	–	Generally Solitary axillary, Sometimes racemose (***Althea***) or solitary terminal (***Abutilon***).
Flower	–	*Bracteate*, Bracteolate, actinomorphic, bisexual, hypogynous, pentamerous, Complete.
Epicalyx	–	3 – 7 bracteoles, free, green, epicalyx absent in ***Abutilon***, ***Bombax*** and ***Sida***.
Calyx	–	5, gamosepalous, valvate aestivation, persistant calyx found in ***Abelmoschus*** & ***Gossypium***, odd sepal posterior.
Corolla	–	5, polypetalous, twisted aestivation, mucilaginous.
Androecium	–	Many stamens, monoadelphous, filaments fused to form a staminal tube/ canal. Epipetalous, Extrorse anther, Reniform, Monothecous, Dorsifixed
Gynoecium	–	Usually 5 – carpellary or polycarpellary (Tricarpellary in ***Kydia***), syncarpous, 5 – locular or multilocular ovary superior ovary, axile placentation, 5 or many free stigmas, The ovary and style are enclosed by staminal tube.
Fruit	–	Capsule (**Cotton**), schizocarp (***Althea***) or berry (**Malva viscus**).
Pollination	–	Usually cross by insects due to dichogamy, Protandry.
Other Important feature	–	Mucilage is found in various plant organs like flower, fruit etc. Star shaped (stellate) hair found on the shoot.

Economic Importance

1. Vegetable

Abelmoschus esculentus (lady's finger) = Okra.

2. Fibres

(i) ***Gossypium*** (= Cotton) – Seeds of *Gossypium* are densely clothed with long hairs which are the source of cotton. These fibres of cellulose are epidermal outgrowth of seeds. The important *Gossypium* species are – G. *barbadense* (Egyptian cotton), *G. hirsutum* (Narma cotton), *G. arboreum* (Tree cotton) and *G. herbaceum*. The former two species are known as new world cotton and the latter two are known as old world cotton.

(ii) ***Hibiscus cannabinus*** **is known as Madras hemp or Deccan hemp or patsan**. The fibres are obtained from the bast of the stem.

(iii) ***Hibiscus sabdarifa*** **is known as Rosella hemp or Patwa**. The fibres are obtained from the bast of the stem.

3. Oil

(i) Seeds of *Gossypium* are a source of fatty oil (cotton seed oil) which is edible and is used for the manufacture of soaps, lubricants etc. The oil – cake is rich in protein and is a very good cattle – feed.

(ii) ***Hibiscus cannabinus*** – Seeds yield a fatty oil which is used as a lubricant and in the manufacture of linoleum, paints and varnishes. The refined oil is edible.

4. Medicinal plants

(i) Roots of ***Urena repanda*** are used for treatment of hydrophobia.

(ii) Roots of ***Malva verticillata*** are used in the treatment of whooping cough.

(iii) Seeds of ***Abutilon indicum*** are used as laxative for constipation.

5. Perfume

(i) Roots of ***Pavonia odorata*** is used for preparation of the perfume, **hina**.

6. Ornamental plants

(i) ***Hibiscus rosa*** – *sinensis* (China rose or shoe flower)

(ii) ***Althea rosea*** (Hollyhock or Gulkhera)

(iii) ***Pavonia odorata***

(iv) ***Thespesia populnea*** (Umbrella tree or Paras peepal)

(v) ***Hibiscus mutabilis*** (Changeable rose or Cotton rose)

7. Timber

(i) ***Ochroma lagopus*** (Balsa wood) – Lightest wood.

(ii) ***Malva sylvestris*** (Mallow wood)

8. Vitamins

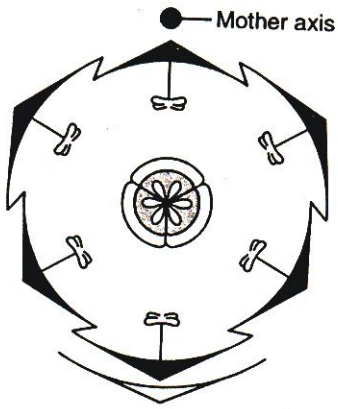
(i) Gossypium seeds are rich in vitamin A, D, E & B - Complex.

FAMILY : LILIACEAE

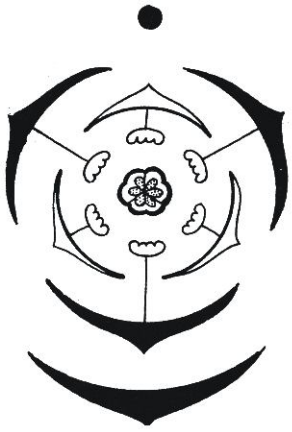
(LILY FAMILY)

Floral Formula

$$Br \oplus \varphi \; P_{3+3 \text{ or } (3+3)} \; A_{3+3} \; \underline{G}_{(3)}$$



Floral Diagram of Allium cepa (Piaz)



Floral Diagram of Asphodelus Tenuifolius (Piazi)

Important Characters of Family Liliaceae

Habit	–	Mostly perennial herbs.
Root	–	Adventitious because Liliaceae is a monocot family.
Stem	–	Rhizome (**Aloe**) or bulb (**onion, garlic**) or Corm (***Colchicum***).
Leaf	–	Exstipulate, Alternate, radical or cauline, parallel venation (Reticulate in ***Smilax*** & ***Paris*****)**.
Inflorescence	–	Simple or branched racemes (penicle).
Flower	–	Bracteate, Bisexual (unisexual in ***Ruscus*****,** ***Smilax***), actinomorphic (zygomorphic in ***Lilium***), hypogynous, trimerous.
Perianth	–	6 tepals in two whorls of 3 each may be polytepalous or gamotepalous (Sepaloid in Onion, Petaloid in Lily).
Androecium	–	6, in two whorls of 3 each (only 3 in ***Ruscus***), opposite tepals, epiphyllous, anthers dithecous, basifixed.
Gynoecium	–	Tricarpellary, syncarpous, trilocular, superior, axile placentation, stigma trifid.
Fruit	–	Usually a capsule (onion).
Pollination	**–**	Usually cross.

Economic importance

1. Food plants

(i) ***Allium cepa*** (onion) – Bulbs are used as vegetable, Pungent smell is due to sulphur allyl sulphide (sulphur compound).

(ii) ***Allium sativum*** (garlic) – Bulbs are used in food items, Antidiabetic property is due to AA – S – allyl cysteine sulphoxide (SACS) in fleshy leaves .

(iii) ***Asparagus officinalis*** – Fleshy shoots are used as vegetable.

2. Medicinal plants

(i) ***Smilax zeylanica*** – Roots are used in dysentery and gout.

(ii) ***Smilax ovalifolia*** and ***S. china*** constitute the drug 'Sarasparilla' which is used in the treatment of skin and veneral diseases.

(iii) ***Aloe barbadensis*** (Indian aloe) – Its fleshy leaves are laxative.

(iv) ***Fritillaria cirrhosa*** – Dried bulbs are given in asthma, bronchitis and tuberculosis.

(v) ***Urginea indica*** – Bulbs are used in dropsy, rheumatism, skin diseases and as heart–stimulant.

(vi) ***Colchicum luteum*** – Corms and seeds are useful in liver diseases and rheumatism and externally in inflammation.

Colchicine (mitotic poison) is obtained from the corm of ***Colchicum autumnale*** (Autumn crocus).

3. Fibres

Leaves of *Sansevieria* and Stem of ***Yucca*** *alolifolia* (Dragger plant) furnish fibres which are used for matting and cordage.

4. Condiment

Leaves of ***Smilax ornata*** (Tejpatra) are used for flavouring curries and vegetables.

5. Ornamental plants

(i) ***Tulipa*** (tulip)

(ii) ***Lilium*** (lily)

(iii) ***Gloriosa superba*** (glory lily)

(iv) ***Asparagus*** (*satawar*) – cladode

(v) ***Ruscus*** – cladode

(vi) ***Dracaena draca*** (dragon plant or dragon's blood) – Red coloured resin is obtained from the stem.

6. Others

A rodenticide is prepared from the bulbs of ***Urginea indica***.

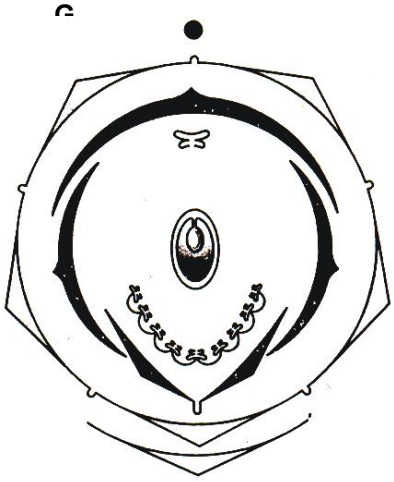
FAMILY : LEGUMINOSAE (FABACEAE)

(LEGUMES OR PULSES FAMILY)

(A) Sub–family : Papilionatae (Pea family, Lotoideae)

Floral formula

$$\text{Br. \%}\ \varphi\ K_{(5)}\ C_{1+2+(2)}\ A\ \underline{G}$$



Floral Diagram of Pisum Sativum (Garden Pea)

Important characters of sub–family Papilionatae

Habit	–	Herbs or herbaceous climbers, sometimes twinners and trees.
Root	–	Tap, nodules on lateral roots.
Leaf	–	Stipulate, alternate, pinnately or digitately compound, leaf base pulvinus.
Inflorescence	–	Racemose raceme.
Flower	–	Bracteate, zygomorphic, bisexual, hypogynous or perigynous, pentamerous.
Calyx	–	5, gamosepalous, valvate or imbricate aestivation, odd sepal anterior.
Corolla	–	5, polypetalous, papilionaceous, descending imbricate (vexillary) aestivation.
Androecium	–	10, diadelphous 1 + (9), dithecous.
Gynoecium	–	Monocarpellary, superior, unilocular, marginal placentation, style slightly curved.
Fruit	–	Legume or pod.
Pollination	–	Usually cross by insects.

Economic importance

1. Pulses

Cotyledons provide pulses which are rich source of proteins.

(i) ***Cicer arietinum*** – chick pea or gram = chana

(ii) ***Cajanus cajan*** – pigeon pea or red gram = arhar

(iii) ***Vigna mungo*** *(Phaseolus mungo)* – black gram = urad

(iv) ***Vigna radiata*** (*Phaseolus radiatus*) – green gram = mung

(v) ***Vigna aconitifolia*** (*Phaseolus aconitifolius*) – dew gram = mothh

(vi) ***Vigna unguiculata*** (*Vigna sinensis*) – cowpea = lobia

(vii)*Lens culinaris* *(Lens esculentum)* – lentil = masoor

(viii)*Phaseolus vulgaris* – French bean = rajma

(ix) ***Glycine max*** = soyabean – max. protein

(x) ***Lathyrus sativus*** = khesari dal – causes lathyrism

2. Vegetables

(i) ***Lablab purpureus*** *(Dolichos lablab)* – hyacinth bean = sem

(ii) ***Cyamopsis tetragonolobus*** – cluster bean = gwar

(iii) ***Vicia faba*** – broad bean = bakla

(iv) ***Trigonella foenum*** – *graecum*

3. Oil

(i) ***Arachis hypogea*** (Ground nut) – The oil is edible. The oil-cake is a useful cattle-feed.

(ii) ***Glycine max*** (soyabean) – The oil is used for cooking and is used in the manufacture of paints and insecticides. The oil cakes are edible and sold as soya nuggets.

(iii) ***Pongamia pinnata*** – Seeds yield pongam oil which is used as a lubricant and in the manufacture of soaps.

4. Fodder

(i) ***Medicago sativa*** – Alfalfa = rijka

(ii) ***Melilotus parviflora***

5. Fibres

Crotalaria juncea (Sun hemp) – The fibres are obtained from the bast of the stem and are used for making ropes and gunny bags. It is also used as green manure.

6. Dyes

(i) ***Indigofera tinctoria*** (indigo = neel) – Indigo dye is used in dyeing and printing cotton and rayon; also used in preparation of paints and printing ink.

(ii) ***Butea monosperma*** (flame of forest or Bengal kino = dhak = tesu) – The flowers yield an orange-red dye. The plant also yields gum.

(iii) ***Pterocarpus santalinus*** (red sandalwood) – The wood contains the red resinous 'santalin', which is used for dying cotton and silk.

7. Medicinal plants

(i) ***Glycyrrhiza glabra*** (liquorice = mulathi) – The roots and stems are used for the treatment of cough.

(ii) ***Abrus precatorius*** (Jewellers weight, Krab's eye plant, Ratti) – The decoction of leaves and roots is used for treatment of cough and cold. The ointment made from leaves is used for treatment of leucoderma.

(iii) ***Pterocarpus marsupium*** (Indian kino) – The wood is used in the treatment of diabetes.

(iv) ***Dolichos biflorus*** (horse gram = kulthi) – Decoction of seeds is diuretic and is also used for the treatment of leucorrhoea.

8. Timber

(i) ***Dalbergia sissoo*** = shisham

(ii) ***Dalbergia latifolia*** (Indian rosewood) = black shisham

(iii) ***Pterocarpus marsupium*** (Indian kino tree) = bejasar

9. Ornamental plants

(i) *Lathyrus odoratus* (sweet pea)

(ii) *Desmodium gyrans* (Indian telegraph plant)

(iii) *Erythrina indica* (Indian coral tree)

(iv) *Sophora japonica* (Japanese Pagoda tree)

(v) *Clitoria tematea* (butterfly pea)

10. Others

(i) ***Alhagi pseudoalhagi*** – It is a camel feed. 'Khas' mats are prepared from it.

(ii) ***Medicago sativa, Trifolium pratense, Lathyrus odoratus*** are used for culture of honeybees.

(iii) ***Lathyrus sativus*** (khesari dal) causes paralysis (lathyrism).

11. Gum

(i) ***Astragalus gummifer*** – Yields tragacanth gum which is used in confectionery and cosmetic preparations and in textile industry.

(ii) ***Cyamopsis tetragonolobus*** (gwar) – It is the source of Gwar gum, used in food, paper and textile industries.

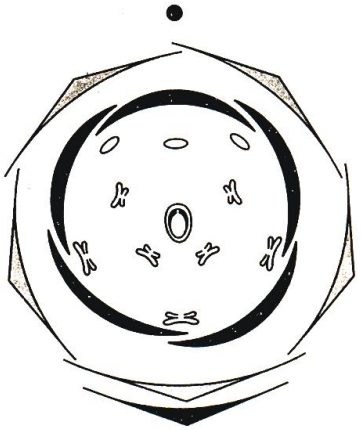
(iii) ***Pterocarpus marsupium*** – Yields Indian kino gum.

(iv) ***Butea monosperma*** – Yields bengal kino gum.

(B) Sub-family : Caesalpinioideae (Cassia family)

Floral formula

Br. % ♂ ♀ K_5 C_5 A_{5+5} $\underline{G}_1$



Floral Diagram of *Cassia Fistula* (Amaltas)

Important characters of sub–family Caesalpinioideae

Habit	–	Mostly trees.
Leaf	–	Stipulate, alternate, pinnately compound.
Inflorescence	–	Racemose raceme or compound raceme.
Flower	–	Bracteate, zygomorphic, bisexual, hypogynous, pentamerous.
Calyx	–	5, polysepalous, odd sepal anterior, Imbricate.
Corolla	–	5, polypetalous, ascending imbricate.
Androecium	–	10 stamens in two whorls of 5 each (Diplostemonous condition), usually 3 posterior stamens are sterile (staminodes) anthers dithecous, introrse.
Gynoecium	–	Monocarpellary, superior, marginal placentation, unilocular.
Fruit	–	Legume.
Pollination	–	Cross by insects.

Economic importance

1. Edible plants

(i) ***Bauhinia variegata*** (Kachnar) – Flower buds are eaten as vegetable.

(ii) ***Tamarindus indica*** (Tamarind = Imli) – Used for souring curries and chutneys.

2. Medicinal plants

(i) ***Saraca indica*** (Ashok tree) – Decoction of bark is used for menstrual disorders.

(ii) ***Cassia fistula*** (Amaltas) – Fruit pulp is purgative.

(iii) ***Cassia glauca*** – Bark and leaves are used in the treatment of diabetes and gonorrhoea.

(iv) ***Cassia sophora*** – Decoction is used for asthma and leaves for ringworm.

3. Dyes

(i) ***Haematoxylon campechianum*** – Heart wood yields haematoxylin dye which is used in biology laboratories.

(ii) ***Caesalpinia sappan*** **(Gulal tree)** – The heartwood yields a dye which is used in dying of cotton, silk and wool.

4. Ornamental plants

Saraca indica, ***Bauhinia variegata, Delonix regia*** = Gulmohar, ***Cassia fistula, Caesalpinia pulcherrima*** (Peacock flower), *Parkinsonia aculeata*.

5. Other uses

Cart-wheels and ploughs are made from the wood of ***Hardwickia binata***.

6. Gum

Gum is obtained from the stems of ***Bauhinia vahlii*** (camel's foot tree) and ***B. variegata***.

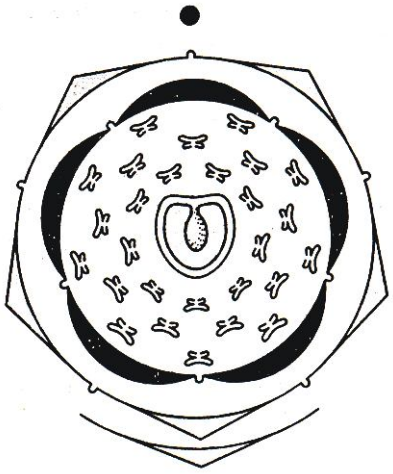
7. Tanning

(i) ***Bauhinia purpurea*** **(ii)** ***Bauhinia malabarica*** **(iii)** ***Caesalpinia digyna***

(C) Sub-family : Mimosoideae (Mimosa Family or Kiker Family or Acacia Family)

Floral formula

Br. $\oplus$ φ $K_{(4 \text{ or } 5)}$ $C_{(4 \text{ or } 5)}$ A_{α} $\underline{G}_{1}$



Floral Diagram of *Acacia Arabica* (Kiker)

Important characters of sub–family Mimosoideae

Habit	–	Usually trees and shrubs.
Leaf	–	Stipulate, alternate, usually bipinnate, base swollen.
Inflorescence	–	Globose head (cymose head) or spike.
Flower	–	Bracteate, actinomorphic, bisexual, hypogynous, sessile, tetra or pentamerous.
Calyx	–	4 or 5, gamosepalous, valvate.
Corolla	–	4 or 5, gamopetalous, valvate.
Androecium	–	Indefinite, arranged in many whorls, polyandrous, anther dithecous, introrse and dorsifixed.
Gynoecium	–	Monocarpellary, superior, unilocular, marginal placentation.
Fruit	–	Legume or lomentum.
Pollination	–	Cross by insects.

Economic importance

1. Timber and fuelwood

(i) Timber and fuelwood are obtained from ***Acacia senegal*** and ***A. nilotica***.

(ii) ***Prosopis cinerarifolia*** (Khejari) – State tree of Rajasthan

(iii) ***Xylia xylocarpa*** – wood is used for making railway sleepers.

(iv) ***Albizia lebbek*** = *Sires*

(v) ***Adenanthera pavonina***

2. **Gum**
   Species of ***Acacia (A. senegal, A. nilotica, A. catechu)*** and ***Albizia (A. lebbeck)*** yield gum.
3. **Catechu**
   The heart wood of ***Acacia catechu*** yields catechu (Kattha).
4. **Edible plants**
   Seeds of ***Pithecellobium dulce*** (Jungle Jalebi) are eaten.
5. **Ornamental plants**
   (i) ***Mimosa pudica*** (sensitive plant = Touch-me-not = Chuimui)
   (ii) Australian *Acaia* sp. *(e.g.* ***A. melanoxylon, A. auriculiformis****)*
   (iii) ***Pithecellobium dulce***
   (iv) ***Neptunia oleracea*** = Kiss me quick = Lajvanti
   (v) ***Albizia sp.***
   (vi) ***Leucaena glauca***
   (vii)*Acacia fanesiana*
6. **Perfume**
   Acacia famesiana is used for making scent.
7. **Shikakai**
   Fruits of ***Acacia concinna*** are used for washing hair.

FAMILY : COMPOSITAE OR ASTERACEAE

(SUNFLOWER FAMILY)

- Important plants of this family are- ***Tagetes*** (Marigold), ***Helianthus*** (Sunflower), ***Lactuca*** (Lettuce), ***Chrysanthemum***. ***Carthamus*** (Safflower or Kusum), ***Parthenium*** (Carrot grass or Congress grass).

Important Characters of family Asteraceae

The plants are mostly herbs, rarely shrubs or trees.

- Stem and roots generally have oil ducts or oil passages.
- Many species are having milky sap in their parts.

Inflorescence

Head or capitulum, a type of racemose in which many sessile flowers are present or borne on a common flat concave or convex receptacle.

This head is surrounded by an involucre (whorl of bracts) at its base, which is protective in function.

- Number of flowers in a head varies from 1 (***Echinops***) to few thousand (***Helianthus***).
- Commonly, there are 2 types of florets or flowers in a head :
  (a) Outer or peripheral ray florets: These are zygomorphic, ligulate, neuter or female.
  (b) Inner or central disc florets: These are actinomorphic, tubular and bisexual.
  Such heads having 2 types of florets are called heterogamous heads.
- In ***Xanthium,*** heads are **homogamous**, *i.e.*. having only one type of florets.
- In a head or capitulum, all the flowers or florets can be pollinated by even a single insect, so it is an advanced type of inflorescence.

Flower

Bracteate, sessile, actinomorphic (disc florets) or zygomorphic (ray florets), bisexual or' unisexual, epigynous, pentamerous.

Calyx

5 sepals, which are generally reduced to persistent tufts of hairs or thin membranes (pappus), which help in dispersal of fruits.

Corolla

5 petals, gamopetalous, tubular in disc florets and ligulate or strap shaped in ray florets, aestivation-valvate.

Androecium

5 stamens, epipetalous, syngenesious, *i.e.,* anthers are fused (filaments free), anthers-dithecous and introrse.

Gynoecium

Bicarpellary, syncarpous, ovary- inferior, unilocular with basal placentation (having single basal ovule).

Fruit

Cypsella, *i.e.,* achene with persistent hair or pappus.

Floral Formula

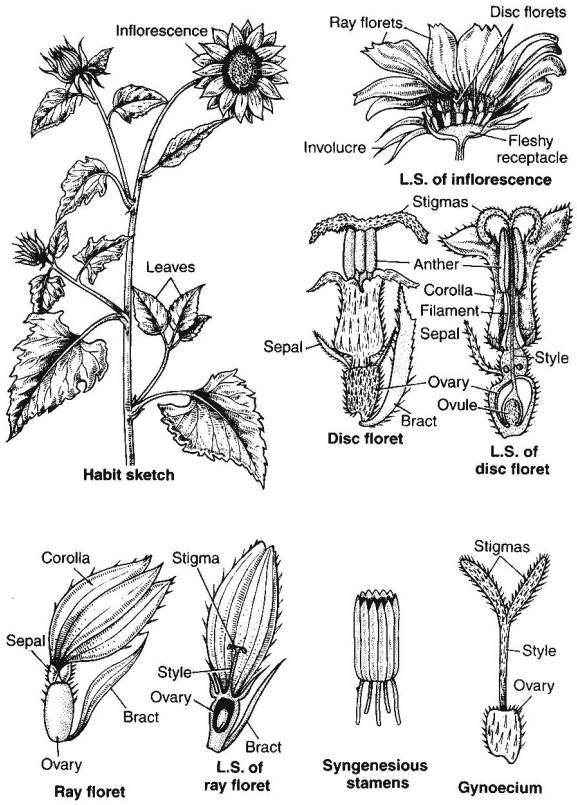
Ray florets :

(a) **Ligulate and female : Br. + ♀ $K_{5\ (pappus)}\ C_{(5)}\ A_0\ \overline{G_{(2)}}$**

(b) **Ligulate and neuter : Br. + $K_{5\ (pappus)}\ C_{(5)}\ A_0\ G_0$.**

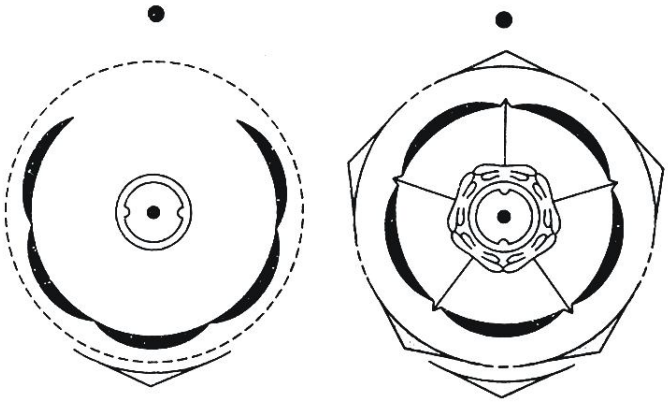
Disc florets :

Br. ⊕ ♀♂ $K_{5\ (pappus)}\ \overline{C_{(5)}\ A_{(5)}}\ \overline{G_{(2)}}$



Parts of flower Helianthus annuus

Floral Diagram



(1) (2)

Floral Diagrams of (1) Ray, (2) Disc florets of Helianthus annuus (Surajmukhi)

Distinguishing Features of The Family

I. Plants generally herbs having oil ducts in stem and root.
2. Inflorescence–head or capitulum.
3. Epigynous flowers.
4. Sepals are reduced to hairy '**pappus**'.
5. 5 epipetalous stamens with syngenesious condition.
6. Bicarpellary, syncarpous gynaecium with basal placentation.
7. Cypsella fruits.
   - This family is considered to be highly evolved or advanced family, because of:
     (a) Surity in pollination.
     (b) Due to single basal ovule, better development of seed occurs.
     (c) Syngenesious condition, etc.

Economic Importance

The plants of this family are sources of food, oil, medicines, dye, rubber, etc. Besides, a large number of plants are ornamentals and weeds.

1. Sources of food

(i) ***Cichorium intybus*** (Chicory or Kasni)- Roots are source of 'Chicory powder', which is used for blending coffee.

(ii) ***Lactuca sativa*** (Garden lettuce or Salad)-This is a salad crop and leaves provide a valuable salad throughout the world.

(iii) ***Helianthus tuberosus*** (Jerusalem artichoke or Hathichuk)- The tubers are source of food or vegetable (having plenty of Inulin).

(iv) ***Trogopogen porrifolium*** (vegetable oyster)- Edible.

2. Sources of medicines

(i) ***Artemisia cina* or *A. maritima*** (worm weed)- A wormicide (anthelmintic) 'Santonin' is obtained from dried unopened flower heads, which is used as vermifuge or in expelling the intestinal worms.

(ii) ***Arnica montana*** – This plant yields 'Arnica', which used as hair vitalizer.

(iii) ***Eclipta prostrata*** (bhringraj) – Its extract is used hair tonic.

(iv) ***Calendula officinalis*** – 'Calendula' drug obtained from dried ligulate florets is used in sprains.

(v) ***Taraxacum officinale*** (Common dendelion) – Drug 'Taraxacum' obtained from roots and rhizomes is used as laxative and liver tonic.

3. Sources of insecticide

(i) ***Chrysanthemum marschallii*** and ***C. cinerariaefolium*** (Guldaodi)- Flower heads are source of a commercial insecticide 'Pyrethrum'.

4. Sources of oils

(i) ***Carthamus tinctorius*** (Safflower or Kusum)- Seeds yield oil, which is edible and because it has high percentage of unsaturated fatty acid, so it is very good for heart patients.' The oil is also used in soaps, varnishes, paints, etc.

- A red dye **'Kusum'** is also obtained from its flowers, which is used in foods as well as clothes.

(ii) ***Helianthus annuus*** (Sunflower, or Surajmukhi)- Seeds are source of edible fatty oil.

5. Sources of rubber

(i) ***Taraxacum kok-saghyz*** (Russian dendelion) – Roots, contain latex, which is the source of 'Dendelion rubber.'

(ii) ***Parthenium argentatum*** – In America, Guayule rubber, is obtained from this plant, because 'caoutchouc' granules are present in plant body.

6. Ornamentals

(i) ***Helianthus annuus*** (Sunflower).
(ii) ***Tagetes sps.*** (Marigold or Genda).
(iii) ***Chrysanthemum* sps**. (Guldaodi).
(iv) ***Calendula officinalis*** (Pot marigold).
(v) ***Cosmos bipinnatus.***
(vi) ***Zinnia elegans.***
(vii) ***Dahlia pinnata***, etc.

7. Others

(i) **Parthenium *hysterophorous*** or ***P. argentatum*** (Carrot grass or Congress grass).

- This is an American plant, which is'nowadays most troublesome terrestrial weed in India. Skin allergy is caused by this plant (contains trans-cinnamic acid).

(ii) ***Ambrosia artemissifolia*** (Rugweed) – An allergic fever called 'Hay fever' is caused by pollens of this plant (aeroallergen).

FAMILY : GRAMINEAE OR POACEAE

Important characters of Family Poaceae

- The members of this family are commonly known as 'grasses'.
- Plants are mostly herbs having stem with marked solid nodes and hollow internodes, i.e., stem is culm. Further stem is generally circular and hollow.
- Leaves simple, alternate, with sheathing bases and ligulate (i.e., a membranous outgrowth 'ligule' is present at junction of leaf sheath and leaf lamina).
- Spikelet (not flower) is the unit of inflorescence, which may be arranged in spike or panicle, i.e., inflorescence is spike of spikelets or panicle of spikelets.

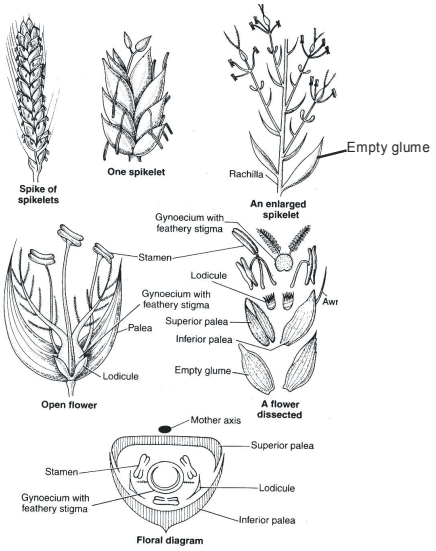
- Each spikelet is having I - 5 flowers on a reduced axis, which bear two leaf like structures (glumes) at base. Each flower is in axil of other leaf like structure called 'lemma' (bract). On the flower axis is another leaf-like structure called palea (bracteole). Above palea are two scale like lodicules (perianth).
- Flower is hypogynous and zygomorphic.
- Perianth reduced and represented by lodicules.
- Generally 3 stamens with dithecous and versatile anthers.
- Carpel is generally 1, unilocular ovary with basal placentation, 2 long styles ending in feathery stigmas.
- Fruit is karyopsis or grain (single seeded indehiscent fruit, in which seed coat fuses with fruit wall to form husk).

Floral Formula

Br. Brl. $\varphi\,\sigma\,P_{2\ (lodicules)}\ A_3\ \underline{G_1}$

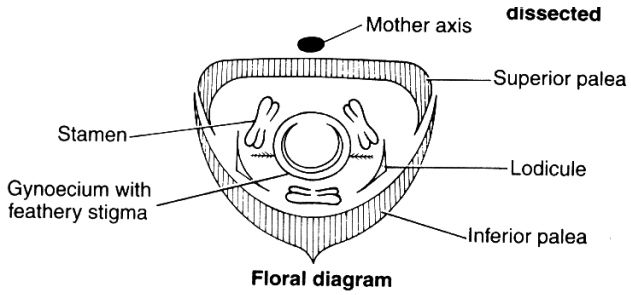
or

$3+3$



Triticum aestivum (Wheat) : A spike of spikelets, one spikelet, an enlarged spikelet, an open flower and floral diagram

Floral Diagram



Economic Importance

1. Cereals and millets :

Most important source of food in the world is cereals having karyopsis or grain fruit, e.g., ***Triticum vulgare*** (Wheat), ***Zea mays*** (Maize), ***Oryza sativa*** (Rice), ***Avena sativa*** (Oat), ***Hordeum vulgare*** (Barley).

Small sized grains constitute millets, which also provide food, e.g., ***Sorghum vulgare*** (Jawar), ***Pennisetum typhoides*** (Bajra), ***Eleucine coracana*** (Ragi or Mandua).

2. **Source of sugar :**

Saccharum officinarum (Sugar cane): Most important source of sugar in world.

3. **Other plants :**

(i) ***Bambusa* sps.**

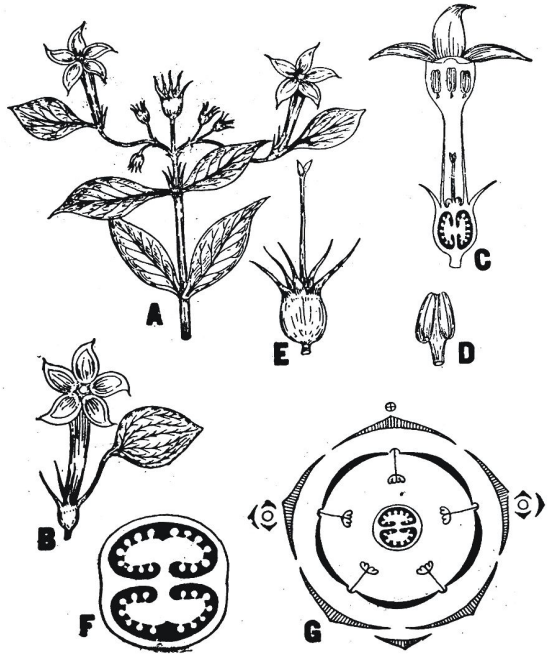
(ii) ***Dendrocalamus sps*** : Both (i) and (ii) provide bamboo for chairs, baskets, poles, etc.

(iii) ***Cynodon dactylon*** (Doob grass) : Fodder.

(iv) ***Andropogon muricatus*** (Khas) : Roots provide khas oil.

FAMILY RUBIACEAE

- **The Rubiaceae are a predominantly arborescent taxon**. Tall trees are represented by ***Cinchona officinalis, Nauclea cadamba*** and others; *Hamelia patens, Mussaenda luteola* and ***Coffea arabica*** are shrubs. Species of the genera ***Oldenlandia, Galium*** , ***Borreria*** and others are herbs.
- **Inflorescence** – The typical inflorescence is of the cymose type. Solitary flowers occur in *Gardenia, Randia* and others. In *Nauclea, Cephalanthus* etc., the cymes are condensed to form globose heads.



Mussaenda luteola

A. A flowering twig. B. A flower showing one other five sepals greatly enlarged like a flag C. Saiittal half of a flower. D. An anther in face view. E. Gynoecium of a flower in which all the five sepals are of equal size. T.S. ovary. G. Floral diagram.

Flower – Bracteate, often bracteolate, penta- or tetramerous, usually bisexual, sometimes unisexual as in ***Coprosma,*** tetracyclic, actinomorphic.

Calyx – Five or four polysepalous, valvate. In ***Mussaenda*** and ***Warscewiczia,*** in some of the flowers of the inflorescence one of the sepal is greatly enlarged into a leaf-like structure which is white, yellow or orange in colour making the flower more conspicuous.

Corolla – Five or four, the petals in this family are usually described as united. The aestivation of the corolla varies, valvate as in ***Oldenlandia, Mussaenda;*** imbricate as in ***Rondeletia*** or twisted as in ***Gardenia.***

Androecium – Five or four, epipetalous. The anthers are basifixed, dithecous and dehisce introrsely.

Gynoecium – Bi-to multicarpellary, syncarpous. The ovary is usually inferior except in ***Synaptanthe*** where it is half inferior and superior as in ***Gaertnera*** and ***Pagamea***. The placentation is axile. In ***Gardenia***, the ovary is unilocular with parietal placentation.

Flower Formula

Br. Brl.$_2$ $\oplus \varnothing$ K_{5-4} $\overset{\frown}{C_{(5-4)}\,A_{5-4}}$ $\overline{G}_{(2)}$

Fruit and Seed – The fruit is a dry capsule as in ***Cinchona*** or a berry as in ***Mussaenda***, ***Gardenia*** and others. The sepals remain persistent at the top of the fruit

Pollination – Pollination by insects. Cross-pollination is favoured by protandry and wide occurrence of heterostyly. In the absence of cross-pollination by insects, self-pollination may occur by the pollen falling on to the stigmas of the same nower.

Economic Importance – Rubiaceae contain a number of economically important plants :

I. Ornamental Plants :

1. *Ixora coccinea*
2. *Hamelia patens*
3. *Mussaenda luteola*
4. *Mussaenda frondosa*
5. *Gardenia lucida*
6. *Cephalanthus occidentalis*
7. *Pentas lanceolata*

II. Drug Plants :

1. ***Cinchona officina*lis** – the bark contains the alkaloid quinine is used against the malarial parasite. Other species of *Cinchona* which yield quinine and other alkaloids are C. *calisaya,* C. *ledgeriana,* C. *cordifolia* C. *sllccirllbra.*
2. ***Gardenia gummifera*** – *the* gum obtained from this plant is used as a carminative stimulant and in dyspepsia.

III. Wood :

1. ***Ixora* ferrea** – yield a very hard wood.
2. ***Anthocephailis indicus*** (Kadamb), *Mitragyna parvifolia* and others furnish a light wood used in the manufacture of toys, furniture, agricultural implements and for turnery and carvings.

IV. Coffee :

1. ***Coffea arabica*** – A native of Abyssinia and East Tropical.

   Africa – The roasted and powdered seeds furnish the coffee powder.
2. ***Coffea liberica*** – *Furnishes* the Liberian Coffee.

V. Dyes :

1. ***Rubia tinctoria*** – The roots contain alizarin and purpurin and were largely used before the introduction of aniline dyes.
2. ***Morinda* species** – The roots contain dyes of various colours as follows :

VI. Minor Uses :

1. ***Anthocephalus indicus*** (Kadam) the fruits are edible.
2. ***Mitragyna parvifolia***, ***Wendlandia exserta*** and several others- the leaves are used as fodder.

EXERCISE

Q.1 Bicarpellary syncarpous pistil, tetradynamous androecium and siliqua fruit occur in –
(1) Fabaceae (2) Solanaceae (3) Brassicaceae (4) Asteraceae

Q.2 Floral formula of Brassicaceae is –
(1) $\oplus\ ♂\ ♀\ K_{2+2}\ C_4\ A_{2+4}\ \underline{G_{(2)}}$ (2) $+\ ♂\ ♀\ K_5\ C_5\ A_{5+5}\ \underline{G_1}$
(3) $\oplus\ ♂\ ♀\ \overset{\frown}{P_{3+3}\ A_{3+3}}\ \underline{G_{(3)}}$ (4) $\oplus\ ♂\ ♀\ K_5\overset{\frown}{C_{(5)}\ A_5}\ \underline{G_{(2)}}$

Q.3 *Atropa belladona,* a medicinal plant belongs to –
(1) Liliaceae (2) Brassicaceae (3) Solanaceae (4) Poaceae

Q.4 Parietal placentation occurs in family –
(1) Brassicaceae (2) Asteraceae (3) Solanaceae (4) Liliaceae

Q.5 Stamens of Brassicaceae are –
(1) Monadelphous (2) Didynamous
(3) Syngenesious (4) Tetradynamous

Q.6 An important feature of Brassicaceae is –
(1) Inferior ovary (2) Cruciform corolla
(3) Axile swollen placentae (4) Oblique ovary

Q.7 Tetradynamous condition occurs in –
(1) Brassicaceae (2) Solanaceae (3) Fabaceae (4) Both 1 and 2

Q.8 Floral formula of family Liliaceae is –
(1) $\oplus\ ♂\ ♀\ P_{3+3}\ A_0\ G_{(\overline{3})}$ (2) $\oplus\ ♂\ ♀\ \overset{\frown}{P_{3+3}\ A_{3+3}}\ \underline{G_{(3)}}$
(3) $\oplus\ ♂\ ♀\ P_{2+2}\ A_6\ \underline{G_{(3)}}$ (4) $\oplus\ ♂\ ♀\ P_3\ A_{3+3}\ \underline{G_{(3)}}$

Q.9 Plants are always herbs in –
(1) Fabaceae (2) Solanaceae
(3) Brassicaceae (4) None of the above

Q.10 Axile placentation occurs in –
(1) Asteraceae and Fabaceae (2) Brassicaceae and Solanaceae
(3) Solanaceae and Liliaceae (4) Brassicaceae and Solanaceae

Q.11 Indian Mustard or Rai is –
(1) *Brassica juncea* (2) *Brassica nigra*
(3) *Brassica rapa* (4) *Brassica campesteris*

Q.12 What is wrong about Solanaceae –
(1) Swollen axile placentation (2) Bicarpellary superior ovary
(3) Monocarpellary superior ovary (4) Epipetalous stamens

Q.13 Four long and two short stamens are characteristic of family –
(1) Solanaceae (2) Asteraceae (3) Liliaceae (4) Brassicaceae

Q.14 $\oplus \male\!\!\female \overset{\frown}{P_{3+3}\,A_{3+3}}\,G_{(\underline{3})}$ is floral formula of –

(1) Liliaceae (2) Brassicaceae (3) Asteraceae (4) Poaceae

Q.15 $\oplus \male\!\!\female\, K_{2+2}\, C_4\, A_{2+4}\, G_{(\underline{2})}$ is floral formula of–

(1) *Allium cepa* (2) *Solanum nigrum* (3) *Helianthus annuus* (4) *Brassica nigra*

Q.16 Myrosin occurs in the family –

(1) Asteraceae (2) Solanaceae

(3) Poaceae (4) Brassicaceae

Q.17 Carpels undergo torsion and are placed obliquely in –

(1) Brassicaceae (2) Solanaceae (3) Asteraceae (4) Liliaceae

Q.18 Commissural stigma (along carpellary cohesion plane) occurs in family –

(1) Solanaceae (2) Liliaceae (3) Cruciferae (4) Fabaceae

Q.19 Red Pepper is –

(1) *Capsicum annuum* (2) *Solanum nigrum*

(3) *Lycopersicum esculentum* (4) *Physalis peruviana*

Q.20 Oil yielding legume is –

(1) *Carthamus* (2) *Glycine max* (3) *Ricinus* (4) *Vigna sinesis*

Q.21 Tetradynamous condition occurs in family –

(1) Asteraceae (2) Solanaceae (3) Brassicaceae (4) Liliaceae

Q.22 Most important character of *Brassica campesteris* is –

(1) False septum (2) Parietal placentation

(3) Ebracteate (4) Imbricate aestivation

Q.23 Which of the family possess perianth of six coloured tepals –

(1) Mimosoideae (2) Solanaceae (3) Liliaceae (4) Malvaceae

Q.24 Epicalyx is characteristics of –

(1) Papilionatae (2) Malvaceae (3) Solanaceae (4) Compositae

Q.25 Persistant calyx is characteristics of –

(1) Allium/Liliaceae (2) Hibiscus/Malvaceae (3) Dalbergia/Papilionatae (4) Solanum/Solanaceae

Q.26 Floral formula of family solanaceae is –

(1) Br Ebrl $\oplus \male\!\!\female\, K_{(5)}\, \overset{\frown}{C_{(5)}\, A_5}\, G_{(\underline{2})}$ (2) Br Ebrl $\oplus \male\!\!\female\, K_{(5)}\, C_{1+2+(2)}\, A_{5+5} G_{\underline{1}}$

(3) Ebr Ebrl $\oplus \male\!\!\female\, K_4\, C_{x\,4}\, A_{2+4}\, G_{(\underline{2})}$ (4) None of the above

Q.27 Tetradynamous condition is characteristics of –

(1) Liliaceae/*Allium/Asphodelus* (2) Cruciferae/*mustard/Iberis*

(3) Malvaceae/*Althea/Hibiscus* (4) Solanaceae/*Nicotiana Petunia*

Q.28 Basifixed monothecous anthers (Or) anthers with two microsporangia is characteristics of –

(1) Leguminosae/Pea (2) Malvaceae/cotton

(3) Solanaceae/Tomato (4) Liliaceae/Onion

Q.29 Infinite monoadelphous stamens occur in –
(1) Gramineae/Paddy (2) Malvaceae/Cotton
(3) Papilionatae/Pea (4) Cruciferae/Mustard

Q.30 Spot out statement applicable to Malvaceae –
(1) Zygomorphic flower (2) Limited stamens
(3) Staminal tube (4) Inferior

Q.31 A special feature of Malvaceae is –
(1) Zygomorphic flower (2) Monoadelphous stamens
(3) Axile placentation (4) Monothecous anthers

Q.32 Staminodes occur in family –
(1) Papilionatae/*Arachis* (2) Malvaceae/*Hibiscus*
(3) Cesalpinoideae/*Cassia* (4) Cruciferae/*Iberis*

Q.33 Parietal placentation and siliqua fruit is fund in –
(1) Malvaceae/Hibiscus (2) Crucifera/Brassica
(3) Compositae/Marigold (4) Solanaceae/Tomato

Q.34 Axile placentation, monoadelphous stamens and polypetalous corolla belongs to –
(1) Solanaceae (2) Malvaceae (3) Liliaceae (4) Cruciferae

Q.35 Axile placentation is found in –
(1) Cruciferae, Malvaceae, Solanaceae (2)Mimosoideae, Malvaceae, Composite
(3) Leguminosae, Liliaceae, Malvaceae (4) Liliaceae, Malvaceae, Solanaceae

Q.36 Perigynous condition is common among –
(1) Liliaceae (2) Solanaceae (3) Leguminosae (4) Malvaceae

Q.37 Which of the family does not possess axile placentation –
(1) Solanaceae (2) Malvaceae (3) Leguminosae/Cruciferae (4) Liliaceae

Q.38 What characterises the family Solanaceae –
(1) Bicarpellary syncarpous ovary (2) Bicarpellary apocarpous ovary
(3) Bicarpellary apocarpous axile (4) Bicarpellary syncarpous axile

Q.39 Bilocular oblique ovary with numerous shining ovule on swollen axile placenta is the characteristics of
(1) Cruciferae (2) Solanaceae (3) Liliaceae (4) Malvaceae

Q.40 Axile placentation epipetalous stamens and gamopetalous corolla belong to –
(1) Malvaceae (2) Solanaceae (3) Liliaceae (4) Leguminosae

Q.41 Smilax is a plant which climbs with the help of stipular tendrils. It belongs, to –-
(1) Cucurbitaceae (2) Papilionatae (3) Liliaceae (4) Gramineae

Q.42 Garlic reduces –
(1) Blood cholesterol (2) Blood urea (3) Blood uric acid (4) Blood serum

Q.43 Pulses belong to (Or) Family which contribute pulses is –
(1) Cesalpionoideae (2) Papilionatae (3) Cruciferae (4) Solanaceae

Q.44 Gram (Cicer) belongs to –
(1) Graminae (2) Papilionatae (3) Cruciferae (4) Solanaceae

Q.45 *Dalbergia* belongs to –
(1) Liliaceae (2) Malvaceae (3) Leguminosae (4) Solanaceae

Q.46 'Indian–telegraph' plant (Or) *Desmodium gyrans* belongs to –
(1) Malvaceae (2) Leguminosae (3) Solanaceae (4) Liliaceaa

Q.47 *Acacia, Albizzia. Prosopis* and *Xylia* belongs to –
(1) Papilionatae (2) Cesalpinoideae (3) Mimosoidae (4) Malvaceae

Q.48 'Simla mirch' (*Capsicum frutescence*) Chillies and Potato belongs to family –
(1) Solanaceae (2) Compositae (3) Gramineae (4) Cruciferae

Q.49 Nicotiana belongs to –
(1) Malvaceae (2) Liliaceae (3) Solanaceae (4) Cruciferae

Q.50 *Atropa belladona* and *Physalis* belong to –
(1) Malvaceae (2) Solanaceae (3) Mimosoidae (4) Liliaceae

Q.51 The floral formula ⊕ ♂ ♀ K(5) C(5) A5 G(2) is that of
[1] Sunnhemp [2] Tobacco [3] Tulip [4] Soybean

Q.52 Phylogenetic system of classification is based on
[1] Chemical constituents [2] Floral characters
[3] Evolutionary relationships [4] Morphological features

Q.53 An example of axile placentation is
[1] Lemon [2] Marigold [3] Argemone [4] Dianthus

Q.54 The technical term used for the androecium in a flower of China rose [*Hibiscus rosa sinensis*] is
[1] monodelphous [2] diadelphous [3] polyandrous [4] polyadelphous

Q.55 Which of these is an example for zygomorphic flower with imbricate aestivation?
[1] *Calotropis* [2] Mustard [3] *Canna* [4] *Cassia*
[5] Cucumber

ANSWER KEYS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ans.	3	1	3	1	4	2	1	2	3	3	1	3	4	1	4	4	**2**
Que.	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
Ans.	3	1	2	3	2	3	2	4	1	2	2	2	3	4	3	2	2
Que.	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**
Ans.	4	3	3	4	2	2	3	1	2	2	3	2	3	1	3	2	2
Que.	**52**	**53**	**54**	**55**													
Ans.	3	1	1	4													